*Decentralized evaluation for evidence-based decision making*

# [Baseline Study of Gansu Smallholder Farmers Growing Zinc-enriched Potatoes Pilot Project]

## [01/05/2019-30/04/2020]

## Final Baseline Report

[April 2020]
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# I. Introduction

1. This report is prepared for the baseline study of Gansu Smallholder Farmers Growing Zinc-enriched Potatoes Pilot Project ("the project"). The study is commissioned by the World Food Program (WFP) China Office and covers the period from May 2019 to April 2020.
2. The purpose of this Baseline Report is to: 1) provide an overview of the country and development context, the subject of the baseline study, as well as the study design; 2) document the fieldwork, data collection and management, and analysis of the baseline survey data; and 3) report key findings. The expected primary users for this baseline report are the WFP China Office and its partners in decision-making, notably related to project implementation.
3. The WFP zinc-enriched potato project was launched on October 22, 2019 and will last until 2023 with the main objectives as below:
    - Objective 1: To increase availability of zinc-enriched potatoes in poor, rural Gansu where the prevalence of zinc deficiency is reported to be high.
    - Objective 2: To increase smallholder farmers' income and hence break the cycle of poverty through enhanced capacity of the targeted, poor, smallholder potato farmers in Gansu across the value chain.
    - Objective 3: To document the impact of this initiative for potential replications/upscaling.
4. The baseline study team is led by Dr. Kevin Chen, Senior Research Fellow and Head of East and Central Asia Office (ECAO) of International Food Policy Research Institute (IFPRI); and Chair Professor at China Academy for Rural Development of Zhejiang University. He is supported by several experts and staff from the fields of economics, nutrition, public health, early child development, potato value chain, and poverty, including Boya Chair Professor Chengfang Liu from School of Advanced Agriculture Sciences, China Center for Agricultural Policy (CCAP), Peking University; Dr. Zihan Li from Langfang Normal University; Dr. Jinhui Fan from the Civil Aviation General Hospital; Dr. Shaoping Li, a postdoctoral researcher at CCAP; as well as Ms. Zimeiyi Wang and Ms. Yunyi Zhou, research staff at ECAO of IFPRI.
5. The baseline survey took place during the period of August 28-September 13, 2019, followed by a complementary survey during October 21-23, 2019 to cover the missing samples. Key findings and recommendations are presented and matched with the baseline study objectives in Table 1.

Table 1. Baseline study objectives, findings, and recommendations

| Baseline study objectives | Key findings | Recommendations |
|---|---|---|
| Assess the current level of zinc deficiency in the project area | 1. Results from hair and dietary zinc tests showed that 20.22% sample children had low hair zinc level, whereas 21.71% children could not reach the recommended nutrient intake (RNI) of zinc as indicated in Chinese dietary reference intake by the Chinese Committee of Health and Family Planning.<br>2. There were higher risks of zinc deficiency among certain groups of children, such as girls (22.25% measured by hair zinc, compared with 17.24% among boys), ethnic minorities (22.12% measured by hair zinc, compared with 17.61% among Han Chinese) and preschoolers (38.27% measured by hair zinc, compared with 14.95% among primary school students). | 1. A significant number of children in the study area face the challenge of zinc deficiency and need interventions to address this challenge.<br>2. The project can consider designing Dongxiang- and female-oriented interventions given their vulnerabilities.<br>3. It is also recommended that the future project interventions can include preschoolers and their families in Dongxiang and Anding as well. |
| Assess local farmers' knowledge of zinc and zinc deficiency | 83.63% of caregivers interviewed in the baseline survey have not heard about zinc. The mean score of the nutrition knowledge test was 0.5/6. Grandparents scored lower (0.48/6) compared with parents (0.59/6). Female caregivers scored lower (0.43/6) than male (0.64/6). | 1. There is an urgent need to design and implement behavior change communications (BCC) activities regarding zinc as an important micronutrient in human body and zinc deficiency.<br>2. Upcoming education activities can also be designed to better target at grandparents and female caregivers. |
| Identify smallholders who are financially/economically poor, as well as their | 1. Potato is the main staple food and also the second largest source for zinc intake in the region.<br>2. Potato varieties grown in the region are not rich in zinc. | 1. Promoting zinc-enriched potato varieties to farmer households could be an effective way to enhance the zinc-intake. |

| | | |
|---|---|---|
| potato farming activities and marketing practices | 3. Farmers picked the potato varieties that gave better taste (37.93%) and yield (36.53%). | 2. When promoting zinc-enriched potato variety, the project needs to consider the taste attribute of the potato varieties.<br>3. When promoting zinc-enriched potato variety, the project needs to consider drought tolerance and yield potential given the harsh conditions in the project area. |
| | 1. An average of 78.18 kg/mu of fertilizer was applied in the potato production in the region, but only 2 farmers had applied zinc fertilizer before.<br>2. Only 35 farmers have heard about the zinc fertilizer. | 1.The project can design interventions to tap the potential of zinc-fertilizer in increasing the zinc content of potato.<br>2. It is important to provide necessary extension services about the zinc fertilizer to the potato farmers in the project area. |
| | 1. Farmers in the region obtained a large share of their income from government transfer payment (40.62%) and nonfarm activities (42.75%).<br>2. Income from agricultural (2.08%) and livestock husbandry activities (7.19%) is small. Only 0.9% of their income is from potato farming.<br>3. 63% of the potato were self-consumed. Self-consumption rate is particularly higher in Dongxiang (80%). | 1. The project needs to rethink its strategy to boost its beneficiaries' income through potato cultivation and marketing, especially for Dongxiang farmers who are in deeper poverty.<br>2. To boost income from potato farming for certain farmers, it is critical to increase both the quality and value of local potatoes such as branding the zinc-enriched potatoes so that they can sell at a premium price. |
| | 1. The baseline survey also revealed large variations between farmers in Dongxiang and Anding. | 1. To make the project more effective, it is important to take the local conditions in the two studied counties into full consideration when designing and implementing interventions in the two counties. |

## II. Country and Development Context

1. Rapid economic growth over the past four decades has made remarkable achievements in eliminating extreme poverty in China. From 2012 to 2019, the rural poor population in China was reduced from 98.99 million to 5.51 million (under the current poverty standard)[1], with a concurrent decrease in the number of people considered food-insecure of 155 million since 1990[2].

2. Improvement in poverty reduction and food security are accompanied by broader social development. Welfare indicators such as nutritional status, educational level, and life expectancy have also been improved. China's Human Development Index[3] value for 2018 was 0.758[4], which put the country in the high human development category (85 out of 189 countries and territories). Its Gender Inequality Index in 2018 was 0.163, ranking 39th of 162 countrie[4]. In 2018, female gross enrolment rates were 81.7% for preschool and nearly 100% for primary school[5].

3. In the deadline year of the nationwide anti-poverty movement, China's No. 1 Document prioritizes the role of agriculture, rural areas and farmers as the cornerstone to win the battle against poverty[6]. The remaining rural residents and counties below the poverty line present fewer challenges but two major obstacles remain: 1) people who are still in poverty fall into the most vulnerable groups, e.g., old-aged, weak, sick or disabled, all of whom lack labor capacity; and 2) the impoverished counties are geographically disadvantaged with insufficient infrastructure, development and public services.

4. Gansu Province is located in less-developed northwestern China. Comparing with 30 other provinces, Gansu's GDP was one of the lowest in 2018[7]. Although Gansu is predominantly an agricultural area, and despite the fact that the per capita landholding is much larger than the national average[8], the frequency of droughts has contributed to low agricultural productivity in the region[9].

5. Potato is one of the few crops which are able to thrive in Gansu's infertile soil[9]. It is also the province's most agriculturally productive product, with the greatest production potential, market advantage and development prospects[10]. In 2017, Gansu

[1]National Bureau of Statistics. 2020. Retrieved at: http://www.stats.gov.cn/tjsj/sjjd/202001/t20200123_1724700.html
[2]de Brauw, A. and Suryanarayana, M.H., 2015. Linkages between poverty, food security and undernutrition: evidence from China and India. *China Agricultural Economic Review*, *7*(4), 655-667.
[3] Human Development Index is a summary measure for assessing long-term progress in three basic dimensions of human development: life expectancy, access to knowledge and a decent standard of living
[4]UNDP. 2019. Human Development Report 2019. Retrieved at: http://hdr.undp.org/sites/all/themes/hdr_theme/country-notes/CHN.pdf
[5]National Bureau of Statistics. 2019. Monitoring Report for the National Women Development Strategy (2011-2020). Retrieved at: http://www.stats.gov.cn/tjsj/zxfb/201912/t20191206_1715998.html
[6]Ministry of Agricultural and Rural Affairs. 2020. No.1 Document. Retrieved at: http://www.moa.gov.cn/ztzl/jj2020zyyhwj/2020zyyhwj/202002/t20200205_6336614.htm
[7] Retrieved at: http://district.ce.cn/zg/201902/02/t20190202_31418762.shtml
[8]Lu, Q., Söderlund, L., Wu, P., & Li, J. (2005). Cultivated land loss arising from the rapid urbanization in China. In *Proceedings SUSDEV-CHINA Symposium: Sustainable Agroecosystem Management and Development of Rural-Urban Interaction in Regions and Cities of China/Leif Söderlund, Jouko Sippola and Mitsuyo Kamijo-Söderlund (eds.)*. MTT.
[9] WANG, C. L., SHEN, S. H., ZHANG, S. Y., LI, Q. Z., & YAO, Y. B. (2015). Adaptation of potato production to climate change by optimizing sowing date in the Loess Plateau of central Gansu, China. *Journal of Integrative Agriculture*, *14*(2), 398-409
[10] Retrieved at: http://jiuban.moa.gov.cn/fwllm/qgxxlb/qg/201711/t20171103_5859933.htm

dedicated roughly 10.83 million mu lands to potato planting, ranking third in the country by area[11]. The total output was roughly 13 million tons, making Gansu the second biggest producer in the country by volume[12]. As a major producing area of high-quality potato, Dingxi alone has 3 million mu potato farmlands and is called the potato town of China[13]. Given China's effort to boost potato cultivation and to transform the crop into the country's fourth staple food after rice, wheat, and corn[14], potato is receiving growing attentions in Gansu.

6. Anding District of Dingxi City and Dongxiang County of Linxia Hui Autonomous Prefecture are still on the list of poverty-stricken counties. Particularly, Linxia is among the "three regions and three prefectures" under extreme poverty. The poverty incident rate of Linxia Hui Autonomous Prefecture in 2018 was 8.97%[15]. Due to the harsh natural condition and high density of ethnic minorities (59%)[16], social and economic development in that area lags far behind other developed regions.

7. Although China has been able to supply adequate calories for its large population, it is still home to the second-largest group of undernourished people in the world according to the 2018 Global Nutrition Report, with vulnerable populations, especially rural residents, suffering disproportionately[17]. Micronutrient deficiencies adversely affect the health and development of Chinese people. Among all the critical micronutrients, zinc deficiency is widespread across the country. A study in 2007 indicated that approximately 100 million Chinese were affected by zinc deficiency, the majority of them living in rural areas[18]. According to the China Nutrition and Health Survey 2002 and 2012, nearly 44.4% of Chinese rural school-aged children were deficient in zinc in 2002, while 10.4% in 2012[19]. As an essential mineral for pregnant women as well as growing children, zinc is involved in numerous aspects of cellular metabolism[20]. Zinc deficiency is usually characterized by growth retardation, loss of appetite, and impaired immune function[21].

8. Currently, there is no institutional intervention program in China tackling zinc deficiency. The scope of the problem is still a black box. Through analysis on soil sample collected in four counties across Gansu showed an average zinc deficiency of 60.12%[22], indicating potential challenges for crops to absorb sufficient zinc from soil and for human to gain adequate zinc intake from local food products[23].

9. Being aware of the zinc deficiency problem and its strengths in potato production,

[11]Retrieved at: http://www.agri.cn/V20/ZX/qgxxlb_1/gs/201805/t20180503_6139440.htm
[12] Retrieved at: http://gs.people.com.cn/n2/2018/0502/c183360-31528424.html
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[15] Gansu government website. 2019. Retrieved at: http://www.gansu.gov.cn/art/2019/4/22/art_39_422103.html
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[20]Sandstead, H.H., 1994. Understanding zinc: recent observations and interpretations. *The Journal of laboratory and clinical medicine*, *124*(3), pp.322-327.
[21]Ploysangam, A., Falciglia, G.A. and Brehm, B.J., 1997. Effect of marginal zinc deficiency on human growth and development. *Journal of tropical pediatrics*, *43*(4), pp.192-198.
[22]Gansu General Station of Agro-technology Extension. 2016. Potato Biofortification Research Project Implementation Report
[23]Alloway, B.J., 2009. Soil factors associated with zinc deficiency in crops and humans. *Environmental Geochemistry and Health*, *31*(5), pp.537-548.

Gansu has been experimenting with zinc-enriched potato since 2013 and already identified varieties with higher zinc content. It has also published several technical standards for zinc-enriched potato cultivation.

10. WFP *China Country Strategic Plan (CSP) 2017-2021* commits to assist the country to achieve Sustainable Development Goal 2, "End hunger, achieve food security and improved nutrition and promote sustainable agriculture"[24]. Gansu province is prioritized given the concentration of poverty and potential zinc deficiency there. Since 1980s, WFP has initiated assistance programs in 3 counties in Gansu (including Dingxi) and played an important role in rural infrastructure improvement and poverty alleviation there[25].

[24]WFP China Country Strategic Plan 2017-2021, 2017, World Food Programme
[25] United Nations World Food Programme in China 1979-2009. 2009. Retrieved at: http://wk.ixueshu.com/file/049c060b5fc030a7318947a18e7f9386.html

## III. Overview of the Baseline Study Design

### 2. Study objectives

2.1. Situation analysis

- Assess the current level of zinc deficiency in treated area;
- Test local farmers' knowledge of zinc and zinc deficiency;
- Investigate food consumption habits and zinc intake of local households;
- Identify smallholders who are financially/economically poor, as well as their potato farming activities and marketing practices; and
- Identify existing potato aggregators as well as market barriers and opportunities for zinc-enriched potato.

2.2. Inform the project design and formulation: provide evidence-based findings to inform operational and strategic decision-making of the project, particularly to guide the delivery of social behavior change campaign (SBCC) activities.

2.3. Establish a reference for the endline study at the end of the project: the endline study will be implemented with the same scope, protocol, and approach of the baseline to gauge changes in nutritional status, awareness, and behaviors brought about by the project interventions.

### 3. Sampling strategy of the baseline study

3.1. The project preselected two treated townships, namely Dashu Township in Dongxiang and Lujiagou Township in Anding. The school targeting strategy of the project includes all the students in grade 1 to 3 in the central primary schools of treated townships and their families as potential treatment group. Student families that grow potato or are willing to do so will receive interventions from the project.

3.2. Considering the future design of the endline survey and the evaluation, the baseline team took a 3-step approach to determine the household samples:

- For each treated township, the team selected another nearby township as comparison, which will serve as a benchmark in the endline study, allowing future researchers to compare with treatment group to see the impacts of project interventions. Based on data and information provided by local governments, comparison townships were regarded as similar to the treated ones in terms of location, economy, agricultural production (particularly potato farming), ethnicity, etc. The selected comparison townships are: Gejiacha Township of Anding and Beiling Township of Dongxiang. This process gave the team four townships to study(Table 2).
- All the students in grade 1 to 3 of the central primary school in each comparison township and their families were flagged to be surveyed, which will not be covered by the project.
- To increase the confidence of the result and better mirror the situation of the whole population, the team also included all the students in grade 4-6 of the four primary schools, plus all the children of the central preschool in each township, as well as their families, in the baseline study. Like those in comparison group, they will not receive project intervention.

Table 2. Treatment status in the baseline study

| Treatment status | Dongxiang County | Anding District |
|---|---|---|
| **Treated** | Dashu Township | Lujiagou Township |
| **Comparison** | Beiling Township | Gejiacha Township |

3.3. In the selected 4 primary schools and 4 preschools, families of 868 students (aged 6-13) and 412 preschoolers (aged 3-6) were included in the evaluation. The total sample size for smallholder household survey was decided as 1,280, including boys and girls transparently and without discrimination.

4. The **data collection methods** applied is primarily **quantitative**, specifically, questionnaire survey, physical examination, cognitive/school performance test, and 2-day 24-hour diet recall conducted in the selected counties. Secondary data from local governments, program office, and other sources was collected as well. **Qualitative methods** adopted by this study include the desk review and analysis of relevant literature and documents, as well as case study during field missions. Conclusions of the study was drawn objectively and based on evidence. Gender lens is applied throughout the evaluation and integrated into key deliverables. The purpose of the adopted methods and their targeted sample are shown in Table 3.

4.1. **Quantitative methods**

- To collect data on indicators of interest to the project, the team designed a set of **questionnaires** targeting sample smallholder households, school/preschool staff, and village officials. The questionnaires include specific gender questions that enable disaggregation of the data to show any different impact in terms of the gender of beneficiary children, caregivers, kindergarten personnel, and smallholders. Before the baseline, four pre-test surveys have been organized, seeking opportunities to tailor the questions based on local situations and make sure that all the questions are carefully worded.
- To assess the nutrient intake, semi-quantitative **food frequency questionnaires** (FFQ) were used for all sample children and their mothers. The study also conducted a **2-day 24-hour diet recall** of selected sample households and children **physical examination** (including anthropometric measures, serum and hair zinc test) to closely look at the zinc intake and body zinc level of sample children who are at particular risk of zinc deficiency.
- The study also administered child **cognition test** and **school performance test** in sample schools as evidence linked them with children's nutrition status, especially zinc level[26] [27] [28].

4.2. **Case study:** Case study was applied in understanding the situation of local potato aggregators, their operational models, good practices, and barriers.

[26]de Moura, J.E., de Moura, E.N.O., Alves, C.X., de Lima Vale, S.H., Dantas, M.M.G., de Araújo Silva, A., das Graças Almeida, M., Leite, L.D. and Brandão-Neto, J., 2013. Oral zinc supplementation may improve cognitive function in schoolchildren. *Biological trace element research*, *155*(1), pp.23-28.
[27]Bhatnagar, S. and Taneja, S., 2001. Zinc and cognitive development. *British journal of nutrition*, *85*(S2), pp.S139-S145.
[28]Warthon-Medina, M., Moran, V.H., Stammers, A.L., Dillon, S., Qualter, P., Nissensohn, M., Serra-Majem, L. and Lowe, N.M., 2015. Zinc intake, status and indices of cognitive function in adults and children: a systematic review and meta-analysis. *European journal of clinical nutrition*, *69*(6), p.649.

Table 3. Match data collection methods and study objectives

| Study objective | Data collection method | Targeted sample |
|---|---|---|
| Assess the current level of zinc deficiency (plus other critical nutrition and development indicators) | Anthropometric measures | All the sample students and preschoolers |
| | Serum zinc test | Sample students in grades 1-6 |
| | Hair zinc test | All the sample students and preschoolers |
| | Cognition test[29] | All the sample preschoolers and students in grades 1-3 |
| | Academic performance test[29] | Sample students in grades 4-6 |
| Assess local farmers' knowledge of zinc and zinc deficiency | One-on-one Questionnaire survey | Primary caregivers of all the sample students and preschoolers |
| Investigate food consumption habits and zinc intake of local household | 2-day 24-hour diet recall | Sample children in the selected 296 sample smallholder households[30] |
| | food frequency questionnaires | All sample children and their mother |
| Identify smallholders who are financially/economically poor, as well as their potato farming activities and marketing practices | One-on-one Questionnaire survey | Primary caregivers of all the sample students and preschoolers |
| Identify existing potato aggregators as well as market barriers and opportunities for zinc-enriched potato | Case study, in-depth interviews | 3 local potato wholesalers/brokers recommended by the government |

5. **Baseline study timeline:** The study commenced in May 1, 2019 upon signing of the contract with WFP and all tasks will be completed by April 30, 2020. Building on the schedule set out in the ToR and updated in the proposal and agreements, the team prepared an overall timeline for the evaluation, including key activities and deliverables and their duration/due date. Debriefing session after the field survey will be organized for the team to communicate with stakeholders.

[29]Cognition and academic performance test are beyond the initial goals of this baseline study, therefore the related findings were presented in Annex G.

[30]Due to budget and time constraints, in each surveyed township, the team selected two villages which have more sample households than others. This strategy gave the team 8 villages and 296 sample households in total to conduct the dietary survey. The team did the sampling work in two steps: 1) The team selected two villages in each treatment and comparison township; 2) All the children in the sample villages who enrolled in the sample school were included in the dietary survey.

6. **Ethics of the baseline study:** The study has obtained ethical approval from the Institutional Review Board (IRB) at IFPRI Headquarter and at Peking University Health Science Center as well. All the caregivers of sample children were asked to read relevant information about the questionnaire survey, physical examination, and cognitive test, and to decide whether the children will participate. Trained enumerators should ensure that the caregivers were fully aware of related risks, especially those in the physical examination. Informed consent forms were signed by the caregivers if they were willing to interact with the procedures. The study values the privacy, confidentiality and anonymity of participants. Although during the field survey enumerators wrote down the participants' names on questionnaires/case study notes, those are for internal use only. No data, view, or statement will be attributed to a named individual, or presented to external audiences in such a way that an individual can be traced as its source.

## IV. Baseline Survey Implementation

1. The baseline survey took place during the period of August 28-September 13, 2019. A total of 74 enumerators recruited by the team and 5 registered nurses from local hospitals firstly gathered in Lanzhou University for a five-day intensive technical and ethical training, plus a field practice run in nearby village and rural preschool. Then, 31 enumerators and 3 nurses were sent to Dongxiang County whereas 27 enumerators and 2 nurses to Anding District to conduct the survey. The remaining 11 enumerators were sent to conduct diet recall at village level.
2. The data collection began on September 2, 2019 and lasted for 11 days till September 13. Household survey enumerators, cognition examiners, and nurses were grouped, managing different aspects of the survey simultaneously while visiting the sample school/preschool as teams. Enumerators covering dietary survey were divided into two teams, visited selected samples in Anding and Dongxiang at the same time.

### 3. Limitations and risks

3.1 Pre-test showed that the questionnaire survey could obtain all the required data. However, there was concern that some sample participants might not show up in the baseline survey due to various reasons. An obvious challenge was that three of the selected townships are mountainous area, which increased the difficulty to invite all the caregivers to complete questionnaire survey at school.

3.2 Participants in the comparison group and complementary group who would not be covered by the project might have low willingness to cooperate during the field survey, posing a potential risk to the study. Supported by representatives from county governments, the team communicated clearly with untreated participant and proceeded with caution.

3.3 The team encountered unexpected barriers when working in Dongxiang County. Local project officials showed little awareness of the project and thus very low willingness to support the field survey. This was largely due to the situation that the baseline survey was conducted before the project officially launched and that there was a significant change of local leadership right before the survey. The unsmooth communication between the team and local officials resulted in a suspension of 2 days in the baseline survey. A complementary survey was organized during October 21-23, 2019 to cover the missing sample as much as possible. It is critical for the Project Management Office of Gansu project to provide full support to the survey team and ensure communicating with the local government officials clearly to get their support before conducting the endline survey.

3.4 The team faced greater challenge during venous blood collection of sample primary school students (Table 4). As a result, the blood collection was suspended in the middle of the way, resulting incomplete samples. It is suggested not to collect the blood sample at the endline survey.

Table 4. Risk, solution, and result of blood test

| Risk | Solution | Result |
|---|---|---|
| Severe fear of blood may | 1) The team invited skilled registered | Several blood phobia and |

| | | |
|---|---|---|
| cause physical reactions such as fainting. | nurses to collect venous blood.<br>2) The nurses paid close attention to the time of blood draw. They worked for 2 hours each morning to avoid letting children wait when hungry.<br>3) After collecting the fasting morning blood, each child was provided with snacks and breakfast immediately.<br>4) Oxygen bag and sphygmomanometer were prepared to deal with blood phobia cases.<br>5) Teachers were responsible for keeping order and comforting students during blood collection. | frightened caregivers cases happened in Dashu Central Primary School. The team took care of all the related medical expenses and canceled serum blood test in Dongxiang County. |
| Caregivers refused their children to be tested due to various consideration, particularly in Dongxiang County. | The team cooperated with principals of sample school/preschool and tried to persuade caregivers. Informed consent forms were signed by the caregivers if they agreed to let their children interact with the procedures. | |
| Local officials were anxious about the safety of blood samples since they carried genetic information of ethnic minority group. | A member of the baseline team was responsible for monitoring the whole process of serum and hair analysis as well as the sample disposal procedure. | The team member made sure that all the serum and hair samples went through the analysis and disposal procedure properly and took notes at every stage. |

4. Table 5 provides the target and achieved sample sizes. Under a handful cases, the team were not able to complete the full survey/examination/test:

   - The caregivers were temporarily not at home (most of these caregivers were then contacted through follow-up visits or phone calls) or could not complete the questionnaire in person (usually due to mental/physical illness).
   - The sample children, although presented on the rosters, had actually transferred to other schools/preschools or in the situation of long-term school absence (particularly in Dongxiang County).
   - The sample child refused to take physical examination/cognition test, and still did not cooperate after several tries.
   - The sample child's hair was too short to be cut for zinc analysis.

Table 5. Target and realized sample sizes

| | Smallholder survey | Anthropometric measurement | Blood test | Hair test | Cognition test | Academic test | Diet recall |
|---|---|---|---|---|---|---|---|
| **Target** | 1,280 | 1,280 | 868 | 1,280 | 901 | 379 | 296 |
| **Realized** | 1,178 | 1,177 | 405 | 805 | 807 | 363 | 295 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Percent of target** | 92% | 92% | 47% | 63% | 90% | 96% | 99% |

5. The 1178 realized smallholder questionnaires provided:
   - personal and family information on 1178 sample children
   - information on the agricultural production and the nutrition awareness of caregivers on 784 household[31] , including 608 households producing potatoes (please refer to Table 81 and Table 82 in Annex J for details).
6. **Data entry, cleaning, analysis and management**
   - All the questionnaires from the field surveys were sent to professional data entry company. The team took steps to backup and protect the data from risk, including scanning all the paper questionnaires so that data are digitalized and stored in secured location, away from damage or unauthorized access.
   - Eight data analysts were recruited to conduct serious and detailed data cleaning using STATA 15.0. The 2-week cleaning procedure included four steps: 1) Outliers and missing value were identified. Logical relationship among related questions were examined and logical flaws were located; 2) Based on the list of all the problematic data. The analyst then went back to cross-check the original questionnaires to see if they were mistakenly entered; 3) The remaining issues after questionnaire checking were solved through follow-up telephone surveys; and 4) Correct data were reentered into the database and double checked.
   - All statistical analysis was performed using STATA 15.0 as well. P-values below 0.05 were considered statistically significant.

[31] Many households have more than one child studying at the sample schools and covered by the survey, that is why the household number is less than the number of sample children

# V. Findings from the Baseline Survey

## 1. Characteristics of Sample Children

1.1 This sub-section begins with the introduction of major characteristics that are of interest to the WFP (Table 6), namely, the location of sample children, their treatment status, their age, gender, and ethnicity, as well as relevant socio-economic conditions, including left-behind status, and household poverty status.

1.2 Among the 1,178 surveyed sample children, 657 of them were from Dongxiang (55.77%, including 363 from Dashu and 294 from Beiling), 521 were from Anding (44.23%, including 255 from Lujiagou and 266 from Gejiacha).

1.3 618 (52.46%) sample children were in treated townships (Dashu and Lujiagou) while another 560 (47.54%) of them living in comparison ones (Beiling and Gejiacha). 252 students in grade 1-3 is expected to receive project intervention (21.39%, including 161 from Dashu and 91 from Lujiagou).

1.4 Anding is a Han-dominated district while Dongxiang has large population of Muslims. 517 or 43.89% of the sample children were Han Chinese, most of the others (661, 56.11%) belonged to either Dongxiang or other ethnic minorities.

1.5 478 children from registered poor households under Gansu's provincial poverty line. The analysis of baseline data also included 233 children who were beneficiaries of the subsistence allowance system and 157 children whose families were defined by Dongxiang County as with difficulties. Taken together, the total number of children from poor households (registered poor households or the subsistence allowance beneficiaries) are 579[32] or 49.15% of sample children. Among the 252 sample students who will receive project intervention, 97 of them (60.25%) in Dashu and 32 of them (35.16%) in Lujiagou were from poor households.

1.6 Left-behind children in China refer to children who remain in rural regions while one or both parents have migrated outside of their hometown of household registration for work for at least 6 months. With this definition, 402 children were defined as left-behind children (34.13%), and 776 children had both parents around (therefore defined as non-left-behind, 65.87%).

[32]The number 579 is lower than the sum of the three types of poor household (868), because there were households reported themselves as different types of poverty at the same time.

Table 6. Sample children: summary statistics

| | Dongxiang County | | | | | | Anding District | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dashu Township | | Beiling Township | | Subtotal | | Lujiagou Township | | Gejiacha Township | | Subtotal | | | |
| | N | % | N | % | N | % | N | % | N | % | N | % | N | % |
| **Overall** | 363 | 30.81 | 294 | 24.96 | 657 | 55.77 | 255 | 21.65 | 266 | 22.58 | 521 | 44.23 | 1,178 | 100.00 |
| **Gender** | | | | | | | | | | | | | | |
| Male | 184 | 50.69 | 152 | 51.70 | 336 | 51.14 | 119 | 46.67 | 130 | 48.87 | 249 | 47.79 | 585 | 49.70 |
| Female | 179 | 49.31 | 142 | 48.30 | 321 | 48.86 | 136 | 53.33 | 136 | 51.13 | 272 | 52.21 | 592 | 50.30 |
| **Education** | | | | | | | | | | | | | | |
| Preschool | 90 | 24.79 | 89 | 30.27 | 179 | 27.25 | 89 | 34.90 | 103 | 38.72 | 192 | 36.85 | 371 | 31.49 |
| Primary school | 273 | 75.21 | 205 | 69.73 | 478 | 72.75 | 166 | 65.10 | 163 | 61.28 | 329 | 63.15 | 807 | 68.51 |
| **Ethnicity** | | | | | | | | | | | | | | |
| Han | 1 | 0.28 | 1 | 0.34 | 2 | 0.30 | 250 | 98.04 | 265 | 0.38 | 515 | 98.85 | 517 | 43.89 |
| Non-Han | 362 | 99.72 | 293 | 99.66 | 655 | 99.70 | 5 | 1.96 | 1 | 99.62 | 6 | 1.15 | 661 | 56.11 |
| **Poverty Status** | | | | | | | | | | | | | | |
| Non-Poor | 150 | 41.32 | 99 | 33.67 | 249 | 37.90 | 166 | 65.10 | 184 | 69.17 | 350 | 67.18 | 599 | 50.85 |
| Poor | 213 | 58.68 | 195 | 66.33 | 408 | 62.10 | 89 | 34.90 | 82 | 30.83 | 171 | 32.82 | 579 | 49.15 |
| **Left-Behind Status** | | | | | | | | | | | | | | |
| Left-behind | 79 | 21.76 | 72 | 24.49 | 151 | 22.98 | 115 | 45.10 | 136 | 51.13 | 251 | 48.18 | 402 | 34.13 |
| Non-left-behind | 284 | 78.24 | 222 | 75.51 | 506 | 77.02 | 140 | 54.90 | 130 | 48.87 | 270 | 51.82 | 776 | 65.87 |

## 2. Hair Zinc Content and Zinc Intake of Children

2.1 Adequate zinc nutrition is necessary for normal child growth, protection from infection, and satisfactory outcomes of pregnancy[33]. Zinc deficiency is characterized by growth retardation, loss of appetite, and impaired immune function[34-35].

2.2 Zinc nutritional status is difficult to measure adequately using laboratory tests due to its distribution throughout the body as a component of various proteins and nucleic acids [36] . Although there is no consensus on appropriate biochemical indicators of body zinc status, several options were adopted in previous studies. This baseline study applied three of the most recommended zinc indicators as shown in Table 7 (Detailed information on data collection and analysis can be found in Annex C and D):

[33]Hotz, C. and Brown, K.H., 2004. Assessment of the risk of zinc deficiency in populations and options for its control.

[34]Maret, W. and Sandstead, H.H., 2006. Zinc requirements and the risks and benefits of zinc supplementation. *Journal of trace elements in medicine and biology*, *20*(1), pp.3-18.

[35]Prasad, A.S., 2004. Zinc deficiency: its characterization and treatment. *Metal ions in biological systems*, *41*, pp.103-138.

[36]Hambidge, K.M. and Krebs, N.F., 2007. Zinc deficiency: a special challenge. *The Journal of nutrition*, *137*(4), pp.1101-1105.

Table 7. Zinc indicators in the baseline study

| Indicator | Characteristics | Application in the baseline |
|---|---|---|
| Serum zinc | Serum zinc level is the most commonly used indicator for evaluating zinc deficiency[37-38]. It is sensitive to short term Zn intake and is often used to measure the effect of zinc supplementation[39]. | Given the tremendous challenges caused by blood phobia and the local cooperation issues in Dongxiang, the team had to cancel the venous blood collection there. Also considering that age-specific serum zinc cutoff has yet been defined in China, as well as unexpected contamination of blood sample, the team focused on hair and dietary indicators instead. |
| Hair zinc | Hair zinc is an alternative indicator used by researchers worldwide. Concentrations of zinc in hair are considered to be more stable and can reflect zinc level in a longer period of time compared with serum zinc[3 7 8]. Cutoff of Chinese children (aged 0-18) hair zinc level (90 μg/g) was defined by the Trace Elements Science Association of China[40]. | Measurement of hair and dietary zinc showed consistency between the two indicators, indicating that 20.22% sample children had low hair zinc level, while 21.3% and 21.71% children could not reach the estimated average requirement (EAR) and the recommended nutrient intake (RNI) of zinc. Since both hair zinc and dietary intake reflect long-term zinc status, the results could to some extent reveal the scope zinc deficiency among sample children. |
| Dietary zinc | Though not a biomarker, the assessment of dietary zinc intake is also a method for estimating zinc exposure in individuals and populations[28-29].<br>Reliable methods have been developed to evaluate dietary zinc intakes and to assess the risk of inadequacy for individuals and population groups[41]. The team combined two recommended dietary assessment methods, namely semi-quantitative food frequency questionnaires and weighted food records.<br>The amount of zinc for each type of food was available from the Chinese Food Composition Table (FCT), which was measured using the neutral detergent method (FIBND). Individual daily intake value for each food item was provided by the dietary data. | |

2.3 **In terms of zinc intake, approximately 20 percent of children could not gain enough zinc from their diet.** The results from the baseline dataset showed that 21.3% of children gained zinc less than the estimated average requirement (EAR), and 21.71%of children with zinc intake less than the recommended nutrient

[37]De Benoist, B., Darnton-Hill, I., Davidsson, L., Fontaine, O. and Hotz, C., 2007. Conclusions of the joint WHO/UNICEF/IAEA/IZiNCG interagency meeting on zinc status indicators. *Food and nutrition bulletin*, *28*(3_suppl3), pp.S480-S484.

[38]King, J.C., Brown, K.H., Gibson, R.S., Krebs, N.F., Lowe, N.M., Siekmann, J.H. and Raiten, D.J., 2015. Biomarkers of Nutrition for Development (BOND)—zinc review. *The Journal of nutrition*, *146*(4), pp.858S-885S.

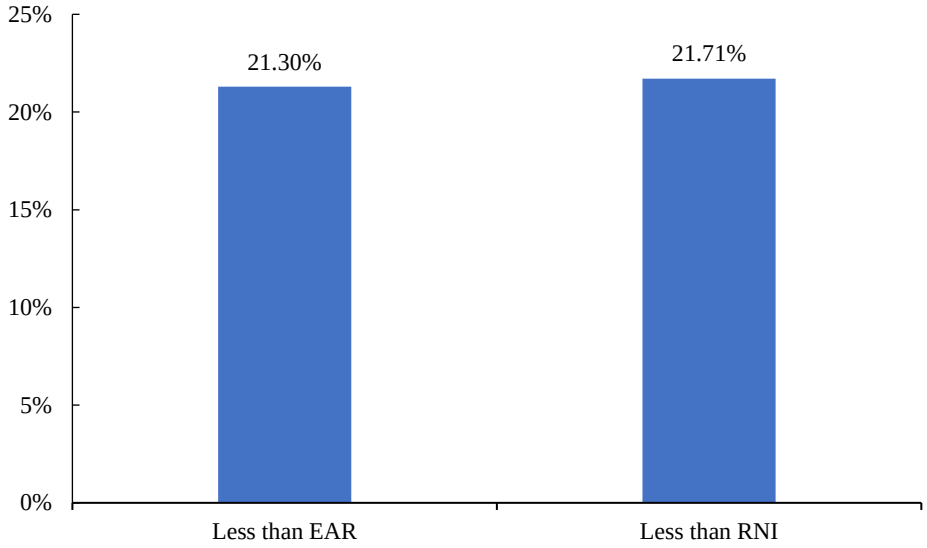
[39]Hess, S.Y., Peerson, J.M., King, J.C. and Brown, K.H., 2007. Use of serum zinc concentration as an indicator of population zinc status. *Food and nutrition bulletin*, *28*(3_suppl3), pp.S403-S429.

[40]Trace Elements Science Association of China. 2005. Reference ranges for 13 trace elements in the hair of Chinese children.

[41]Food and Nutrition Board, Institute of Medicine, 2000. Dietary reference intakes: applications in dietary assessment.

intake (RNI), indicating that these children might face zinc deficiency (Figure 1).

Figure 1. Zinc intake among sample children




2.4 As shown in Table 8, there was also heterogeneity among different age group children. For 2-3 age group, the proportion of children whose zinc intake was lower than EAR was 14.77%, while there were over 22.52% of children aged 4-6 gaining zinc less than the EAR. The indicator of zinc intake less than RNI also showed a similar pattern as EAR.

Table 8. Zinc intake among children

| Age group | Less than EAR (%) | Less than RNI (%) |
|---|---|---|
| 2--3 | 20.45 | 21.59 |
| 4--6 | 23.27 | 23.51 |
| 7--10 | 20.14 | 20.68 |
| 11--16 | 20.96 | 20.96 |

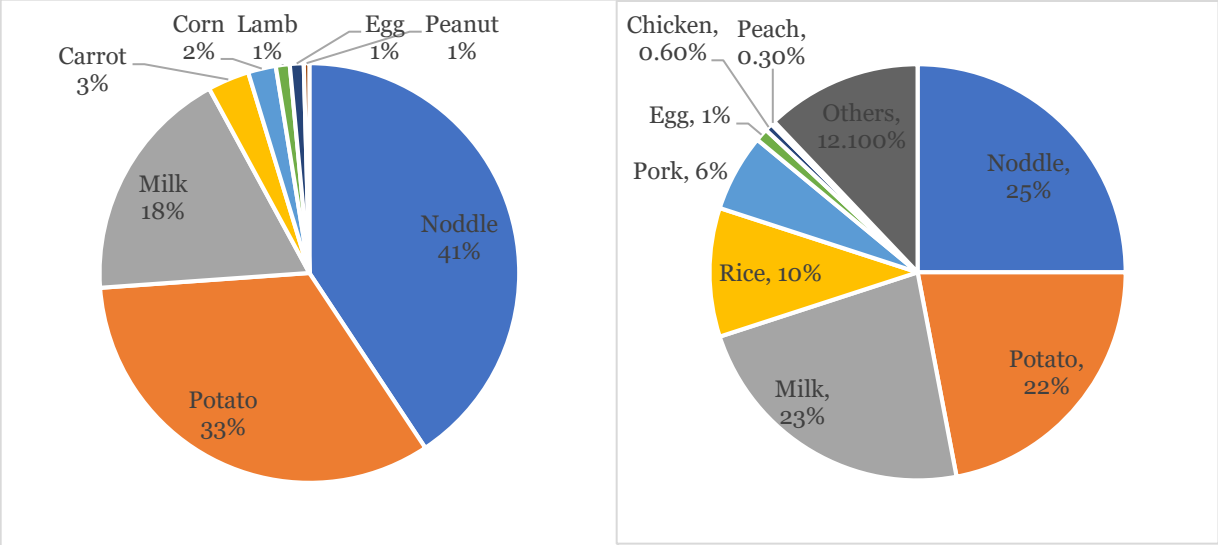
2.5 As shown in Table 9, children in Dongxiang county were more vulnerable to zinc deficiency measured by zinc intake. However, the gap between Dongxiang and Anding was less than 2 percentages. Han children performed better in terms of zinc intake. More girls could not gain recommended amount of zinc than boys. The proportions of children taking zinc less than EAR and RNI among girls were 22.15% and 22.31%, while the proportions among boys were 20.43% and 21.10%. Children in treatment group were more vulnerable to zinc deficiency. The gap between comparison group and treatment group was about 2 percent.

2.6 **Potato was a main source of zinc among sample children**. Figure 2 shows that the top three food sources of zinc among children were noddle, potato and milk in Dongxiang and Anding. Potato was the second largest food source of zinc, accounting for 33% and 22% of zinc intake in Dongxiang and Anding, respectively. On average, each sample child consumed 83.4 g of potatoes every day. The

frequently used methods were frying, boiling, and cooking with noodles.

2.7 A potential implication is that, assuming that the potato consumption and zinc absorption remain constant, if zinc-enriched potato contains two times of zinc than ordinary varieties, the zinc intake of children might increase more than 10 percent. And the zinc deficiency will possibly decrease by 3 percentages.

Figure 2. Food sources of zinc in Dongxiang (left) and Anding (right)




2.8 **Zinc deficiency measured by hair zinc level was diagnosed in 20.22%,** which is consistent with the results measured by dietary zinc intake**. As shown in Table 9, the prevalence of zinc deficiency was alarmingly high among tested preschoolers** (38.27%, while only 14.95% among school students). Clarified by gender, region, treatment status, and other socio-economic status, certain groups tended to have higher zinc deficiency rate, including girls, children from Dongxiang, children in the treated group, ethnic minority children, children from non-poor household, and left-behind children. Those differences were not significantly large (Disaggregated data by township can be found in Annex H).

2.9 Hair and dietary results jointly revealed the scope of zinc deficiency problem. The zinc deficiency rates measured by hair and dietary intake were higher than the 2012 situation among rural school-aged children covered by national survey (Figure 3). Consistency between the two types of indicators were observed across most groups. However, it is also worth noting that the differences within gender, location, and education status seemed broader when measured by hair zinc. On the contrary, the difference between poor and non-poor children was larger when measured by dietary zinc intake. Further consultation with medical experts is needed to interpret the result.

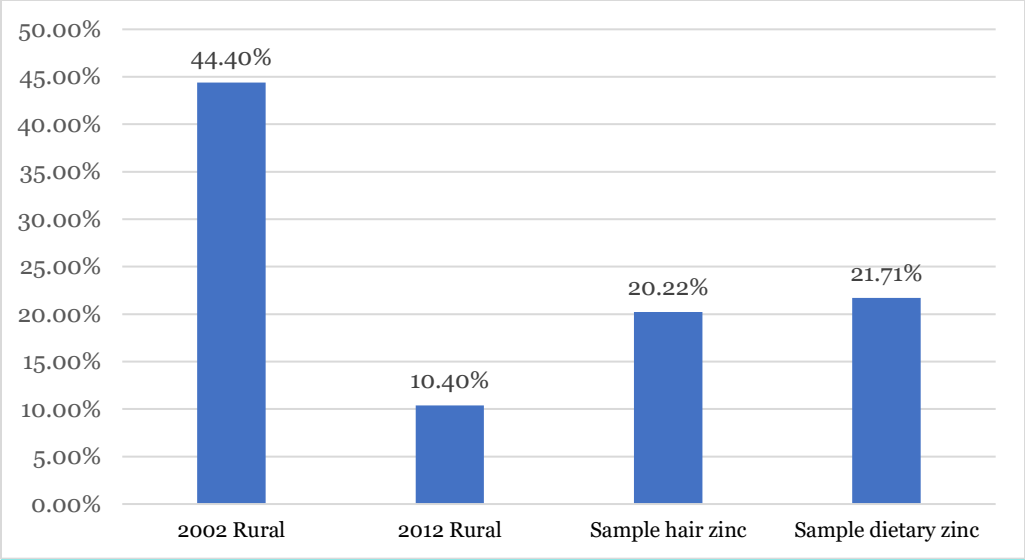



Figure 3. Comparison of zinc deficiency rate between national survey and sample children

Table 9. Disaggregated zinc deficiency status among sample children

| | Hair zinc deficiency | Zinc intake lower than EAR | Zinc intake lower than RNI |
|---|---|---|---|
| **Overall** | 20.22% | 21.30% | 21.71% |
| **County** | | | |
| Dongxiang | 22.14% | 21.78% | 22.54% |
| Anding | 17.65% | 20.93% | 21.08% |
| **Treatment Status** | | | |
| Treated | 20.62% | 21.75% | 22.06% |
| Comparison | 19.76% | 20.82% | 21.33% |
| **Gender** | | | |
| Female | 22.25% | 22.15% | 22.31% |
| Male | 17.24% | 20.43% | 21.10% |
| **Education** | | | |
| Preschool | 38.27% | 23.20% | 23.71% |
| Primary School | 14.95% | 20.41% | 20.77% |
| **Ethnicity** | | | |
| Han | 17.61% | 20.69% | 20.84% |
| Non-Han | 22.12% | 22.14% | 22.90% |
| **Household Poverty Status** | | | |
| Non-Poor | 20.74% | 22.78% | 23.30% |
| Poor | 19.73% | 15.76% | 15.45% |
| **Left-Behind Status** | | | |
| Non-Left-Behind | 19.17% | 18.54% | 20.38% |
| Left-Behind | 22.36% | 25.20% | 23.19% |

## 3. Iron Intake of Children

3.1 Based on the dietary data, the baseline study also calculated the intake of another key micronutrient, namely iron. The results from the baseline dataset showed that 19.81% of children' iron intake was less than the estimated average requirement (EAR), and more than one in five gained less iron than the recommended nutrient intake (RNI), indicating that these children may face iron deficiency (Figure 4).

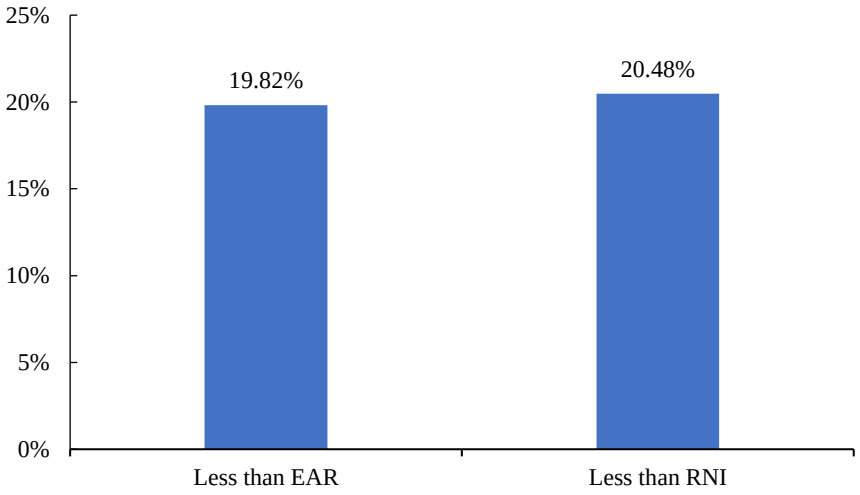



Figure 4. Iron intake among sample children

3.2 As iron deficiency is the most common cause of anemia, child anemia rates measured by previous studies could be used as an approximation of iron deficiency status. 2013 Chinese nutrition and health surveillance showed that the anemia rates of nation-wide rural children and Gansu rural children were 12.40% and 8.10% respectively[42]. Both were lower than the baseline result. A similar study conducted by our team in Xiangxi, Hunan province reported a 33.36% child anemia rate (Figure 5).

[42] Hongyun, F., Dongmei, Y., Qiya, G., Lahong, J., Xiaoli , X., Wentao, Y., Fengmei, J. and Liyun, Zhao., 2018. Anemia prevalence of among 0-5 years old children in China, 2013. *Chinese Journal of Public Health*, *34*(12), pp.1654-1657.

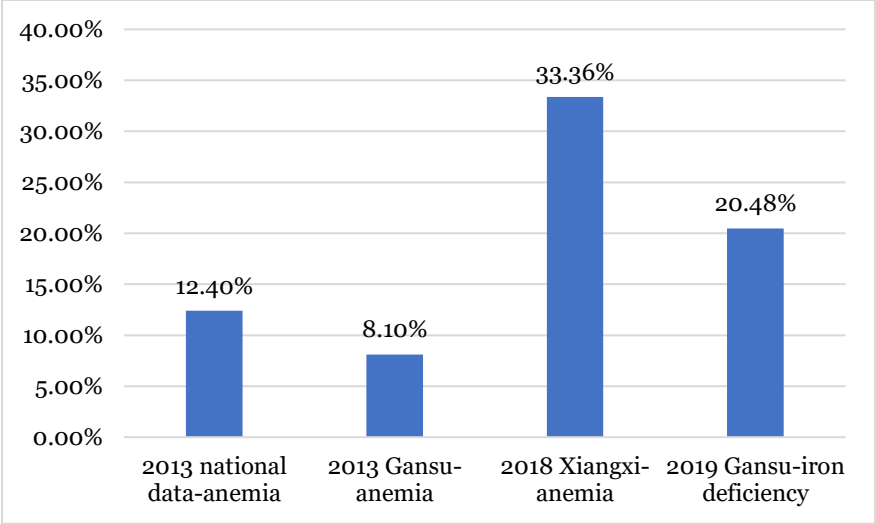



Figure 5. Comparison of children anemia/iron deficiency rates

3.3 There was a huge heterogeneity among different age group children (Table 10). For example, for 2-3 age group, the proportion of children gained iron less than the RIN was nearly 16 percent, while there were 23.51% of children aged 4-6 getting iron less than the RNI.

Table 10. Iron intake among children by age group

| Age group (years) | Less than RNI (%) |
|---|---|
| 2-3 | 15.91 |
| 4-6 | 23.51 |
| 7-10 | 18.88 |
| 11-16 | 20.96 |

3.4 Similar to zinc deficiency, children in Dongxiang were also more vulnerable to iron deficiency. However, the gap between Dongxiang and Anding was smaller (Table 11). Compared with children in comparison group, children in treatment group were more vulnerable to iron deficiency. The gap between comparison group and treatment group was about 2 percentages.

3.5 The baseline study also found that the anemia problem facing girls and boys were different but not significantly. The proportions of children intaking iron less than RNI among boys was 20.27%, while the proportions of girls was 20.68%.

3.6 Data showed that ethnic minority children performed better. This result is not consistent with other studies which found that ethnical minority performed worse. One possible explanation is that people in Dongxiang County are more likely to eat beef and lamb.

3.7 Differences were also observed regarding other socio-economic factors, including education level, household poverty status, and left-behind status. Children from primary school, non-poor family, and with at least one parent at home tended to have lower iron deficiency rate measured by RNI (Table 11).

Table 11. Disaggregated iron deficiency status among sample children

| | Iron intake lower than RNI |
|---|---|
| **Overall** | 20.48% |
| **County** | |
| Dongxiang | 21.02% |
| Anding | 20.06% |
| **Treatment Status** | |
| Treated | 21.59% |
| Comparison | 19.28% |
| **Gender** | |
| Female | 20.27% |
| Male | 20.68% |
| **Education** | |
| Preschool | 22.16% |
| Primary School | 19.69% |
| **Ethnicity** | |
| Han | 21.37% |
| Non-Han | 19.83% |
| **Household Poverty Status** | |
| Non-Poor | 13.82% |
| Poor | 22.16% |
| **Left-Behind Status** | |
| Non-Left-Behind | 18.89% |
| Left-Behind | 22.36% |

## 4. Anthropometric Status of Children

4.1 Based on key anthropometry indicators (height and weight), stunting, wasting, and underweight were calculated to understand child undernutrition status (Detailed explanation about the anthropometric measurement and indicators' definition can be found in Annex E). Considering global upward trend of child overnutrition in middle- and low-income countries[43], the team also reported child overweight and obesity rates to check whether similar trend could be observed in poor counties in China.

4.2 Table 12 shows the prevalence of malnutrition among sample children, by county, treatment status, gender, age, ethnicity, household poverty status, and the child's left-behind status (Disaggregated data by township can be found in Annex I). **Stunting (14.50%) was the most prevalent malnutrition among sample children.**

4.3 According to the Chinese Nutrition and Health Surveillance in 2013, the prevalence of stunting, underweight and wasting among children under 5 in poor rural areas were 18.7%, 5.2% and 3.0%, respectively. In 2018, the baseline team conducted a similar WFP-led study in Xiangxi prefecture of Hunan province. The prevalence of stunting, underweight, and wasting were 10.59%, 5.41%, and 1.73%. Among sample

[43]Tzioumis, Emma, and Linda S. Adair. "Childhood dual burden of under-and overnutrition in low-and middle-income countries: a critical review." *Food and nutrition bulletin* 35, no. 2 (2014): 230-243.

preschoolers, these malnutrition rates were 9.68%, 8.26%, and 7.37% (Figure 6). The prevalence of stunting and wasting among the sample preschoolers are considered medium based on the WHO cut-off for public health significance[44]. On the other end of the spectrum, childhood overnutrition was not a worrisome problem among the sample preschoolers.

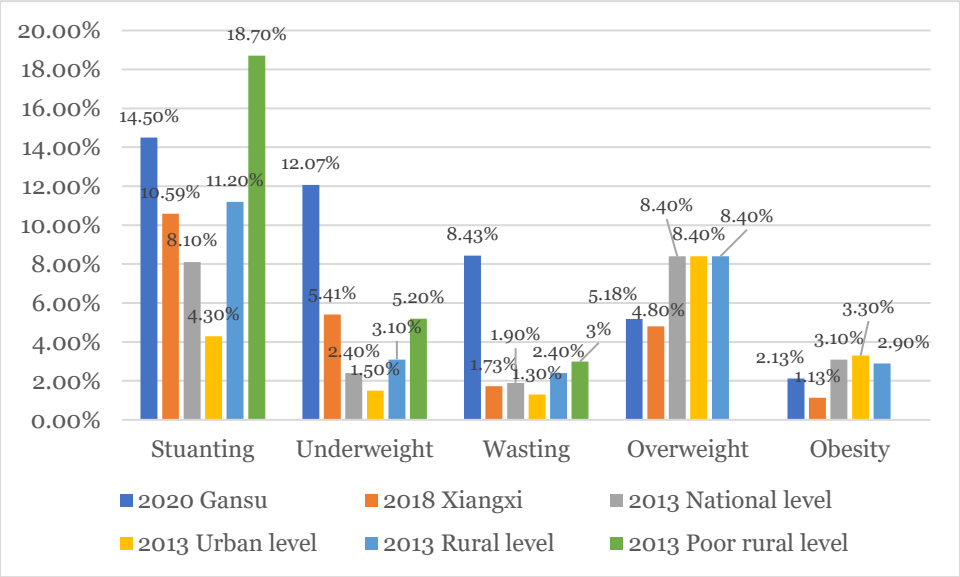



Figure 6. Comparison of anthropometric status of preschoolers

4.4 *Report on Chinese Residents' Chronic Diseases and Nutrition 2015* showed that the prevalence of stunting and wasting among Chinese students aged 6-17 were 3.2% and 9.0%, while overweight and obesity rates were 9.6% and 6.4% (Figure 7). Among surveyed primary school students (aged 6-13), these rates were 15.86% (stunting), 8.72% (wasting), 5.60% (overweight), and 2.60% (obesity). Comparing with the national level, progress could still be made to reduce undernutrition among this age group in the surveyed area.

[44] Nutrition Landscape Information System (NLiS)
http://apps.who.int/nutrition/landscape/help.aspx?menu=0&helpid=391&lang=EN

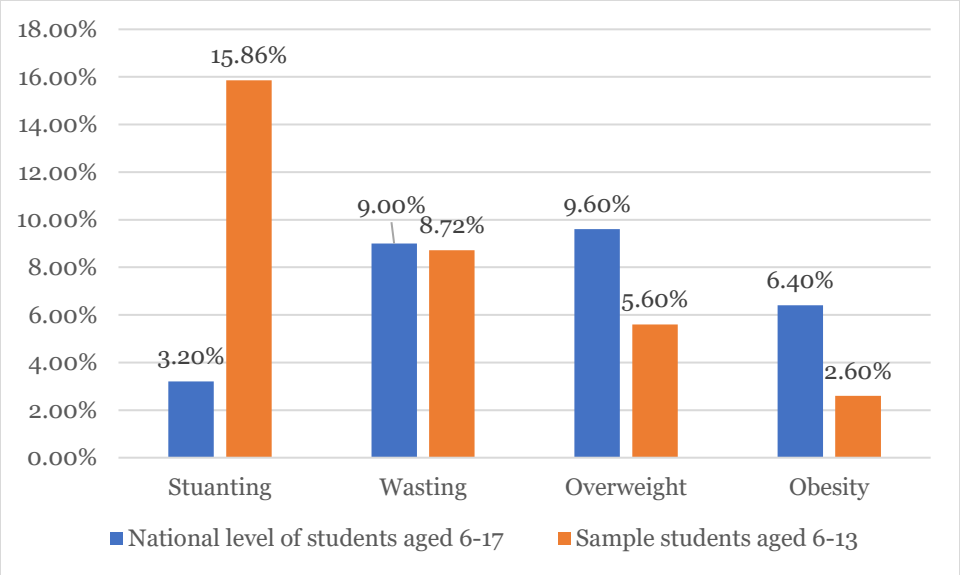



Figure 7. Comparison of anthropometric status of primary school students

4.5 Disaggregated data by county indicate relatively better performance of Anding. **The prevalence of stunting in Anding (8.50%) was significantly lower than that in Dongxiang** (18.60%). The magnitude of underweight and wasting were also lower in Anding but not statistically significant. On the other side, **sample children in Anding were more affected by overweight** (9.27%, compared with 2.39% in Dongxiang) and obesity (3.51%, compared with 1.19% in Dongxiang).

4.6 Prior to the baseline survey, one of the concerns was that malnutrition might affect certain groups of children more than they affect others. The data presented disparities between gender, education, and ethnic groups. The prevalence of stunting (15.86%) and underweight (13.79%) were higher among primary school students. **Han children had better status in terms of linear growth** (stunting rate 8.86% compared with 18.27% among ethnic minority children) but they suffered from higher prevalence of overweight and obesity.

4.7 Disparities also exist between different socioeconomic groups. **Children from wealthier families had higher obesity rate (3.16%)**. **Non-left-behind children experienced higher rates of stunting (16.54%) and underweight (14.59%)**. Possible explanation could be that remittances that migrant parents send home matter. Compared with those doing farm work in their hometown, parents working in developed regions might be able to send more money back home to better support their children's growth. Further analysis is needed to explain the potential correlation.

Table 12. Disaggregated data of child nutrition status

| | | **Undernutrition** | | **Overnutrition** | |
|---|---|---|---|---|---|
| | Stunting | Underweight | Wasting | Overweight | Obesity |
| **Overall** | 14.50% | 12.07% | 8.43% | 5.18% | 2.13% |
| Dongxiang | 18.60% | 13.76% | 9.04% | 2.39% | 1.19% |
| Anding | 8.50% | 9.76% | 7.52 % | 9.27% | 3.51% |
| **Treatment Status** | | | | | |
| Treated | 16.76% | 10.65% | 7.65% | 5.28% | 2.55% |

| | | | | | |
|---|---|---|---|---|---|
| Comparison | 11.67% | 13.79% | 9.40% | 5.05% | 1.61% |
| **Gender** | | | | | |
| Female | 14.72% | 13.65% | 8.89% | 4.85% | 1.41% |
| Male | 14.29% | 10.43% | 7.96% | 5.51% | 2.86% |
| **Education** | | | | | |
| Preschool | 9.68% | 8.26% | 7.37% | 3.69% | 0.46% |
| - National standards | 18.70% | 5.20% | 3.00% | - | - |
| Primary School | 15.86% | 13.79% | 8.72% | 5.60% | 2.60% |
| - National standards | 3.20% | - | 9.00% | 9.60% | 6.40% |
| **Ethnicity** | | | | | |
| Han | 8.86% | 9.97% | 7.61% | 9.39% | 3.55% |
| Non-Han | 18.27% | 13.56% | 8.97% | 2.37% | 1.18% |
| **Household Poverty Status** | | | | | |
| Non-Poor | 13.68% | 10.66% | 8.84% | 5.68% | 3.16% |
| Poor | 15.26% | 13.45% | 8.04% | 4.71% | 1.18% |
| **Left-Behind Status** | | | | | |
| Non-Left-Behind | 16.54% | 14.59% | 8.21% | 4.33% | 1.64% |
| Left-Behind | 10.16% | 7.14% | 8.89% | 6.98% | 3.17% |

## 5. Nutrition Awareness of Caregivers

5.1 Given the fact that zinc is an essential micronutrient associated with over 300 biological functions, zinc supplementation might be a useful treatment among children with zinc deficiency symptoms. However, the willingness of parents to give zinc supplementation to their children is closely associated with their knowledge on zinc nutrition. In the baseline survey, the smallholder household questionnaire includes a 6-question module on knowledge on zinc nutrition (Table 13). The primary caregiver of each sample child was invited to complete this module.

5.2 **Most caregivers were not familiar with zinc.** Specifically, only 16.37% of respondents answered that they heard about zinc and knew that it was a type of element in human body, and 11.10% of respondents thought there was a difference in the demand for zinc among people of different ages. Roughly 6% of respondents knew that people can get enough zinc through daily diet alone. Less than 2% of respondents correctively pointed out the symptom which was caused by zinc deficiency. Less than 13% of child caregivers knew who is most vulnerable to zinc deficiency, and 3.78% of respondents knew those zinc-enriched foods.

Table 13. Zinc knowledge questions and percentage of correct answers

| Items | Options | % |
|---|---|---|
| Do you know that zinc is an element in the human body? | 1=Yes; 2=No | 16.37 |
| Do you think there is any difference in the demand for zinc among people of different ages? | 1=Yes; 2=No; 3=Don't know | 11.10 |
| Without dietary supplements (such as zinc gluconate), can I get enough zinc through my daily diet alone? | 1=Yes; 2=No; 3=Don't know | 6.09 |
| Which of the following is not the main symptoms of zinc deficiency? | 1=Picky eaters; 2=Short stature; 3=Poor eyesight; 4=Anemia; 5=Don't know | 1.64 |

| | | |
|---|---|---|
| Who do you think is most vulnerable to zinc deficiency? | 1=Children; 2=The pregnant; 3=The elder; 4=Person doing heavy work; 5=Don't know | 12.83 |
| Which of the following is not a zinc-enriched food? | 1=Spinach; 2=Banana; 3=beef; 4=Cucumber; 5=Don't know | 3.78 |

5.3 The team then aggregated these responses into a zinc nutrition knowledge score. Each correct response was given one point, if there was more than one correct choice, all the correct choices shared one point, yielding a score ranging between 0 and 6. Figure 8 showed the full distribution of this nutrition knowledge score.

5.4 **In general, child caregivers lacked relevant zinc nutrition knowledge**. The mean score among the caregivers was 0.5 (median: 0). **The zinc nutrition knowledge scores were slightly higher in male caregivers than those of female caregivers**, which were 0.64 and 0.43 respectively. **The parents (0.59) performed better than grandparents** (0.48) of children. The analysis of baseline zinc nutrition knowledge score revealed the necessity to strengthen various approaches of nutrition and child feeding education targeting caregivers. Caregiver groups which had lower scores, namely grandparents and female caregivers, deserved specific attention in the education activities.

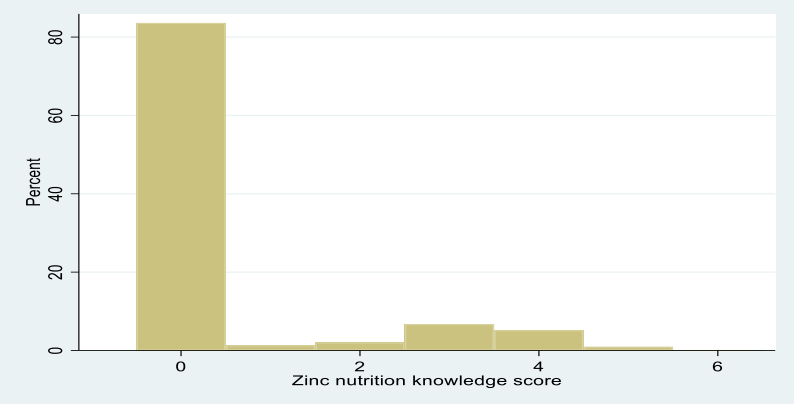



Figure 8. Distribution of zinc nutrition knowledge score of caregivers

5.5 **The difference between treatment group and comparison group in zinc nutrition knowledge score among child caregivers was very small.** The mean score of treatment group was 0.53, which was higher than that of control group (0.50) (Figure 9). However, the difference was not statistically significant.

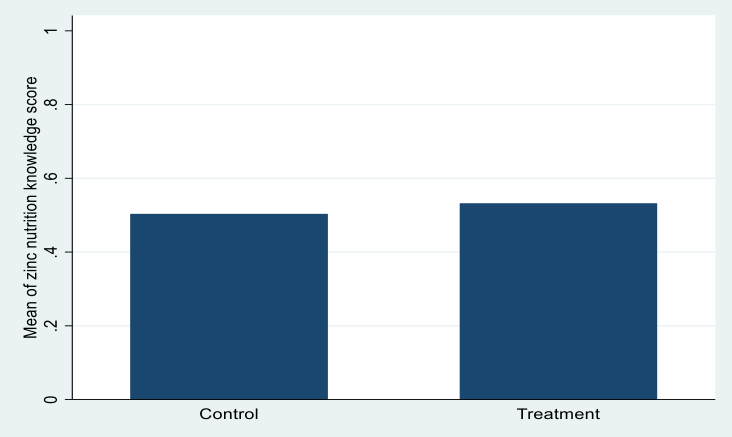



Figure 9. Comparison of mean score of zinc nutrition knowledge by treatment

## 6. Local Agricultural Practices

6.1 Table 14 shows the characteristics of the sample farmers and farming households (including potato farming households) in our sample area (disaggregated data by township can be found in Annex J). It indicates that sample farmers are mainly younger people with low or average education. Dongxiang has more female farmers than Anding among interviewees. The percentage of sample farmers who have ever served a position in the village or town in the farming households is low in both Dongxiang and Anding. In Anding, nearly 99.73% of sample farmers are Han Chinese. However, nearly all the sample framers in Dongxiang are Dongxiang ethic minority. About 80% of sample farmers declared they are in good health status. The participating rate of farmers' cooperative is 5.10%. Only 1.23% of sample farmers have received nutrition training. Nearly half of the sample farmers are officially poor, which means "having registered and filed by government". Specifically, the ratio of sample farming households receiving substance allowance and exceptional poverty allowance in 2018 were 17.98% and 13.14%, respectively. An even larger proportion of sample farming households were receiving filed and registered poor households' allowance (34.06%).

Table 14. Characteristics of sample farmer interviewees by county/district

| | **Dongxiang** | **Anding** | **Total** |
|---|---|---|---|
| Sample farming households | 374 | 410 | 784 |
| Sample potato farming households | 338 | 270 | 608 |
| Treatment households | 184 | 203 | 387 |
| Comparison households | 190 | 207 | 397 |
| Characteristics of the farmer: | | | |
| Age (years) | 41.78 | 46.87 | 44.28 |
| Female (%) | 50.64 | 50.18 | 50.41 |
| Education (years) | 1.85 | 5.51 | 3.65 |
| Characteristics of the farmer households: | | | |
| Family size | 5.11 | 4.37 | 4.72 |

| | | | |
|---|---|---|---|
| Number of children | 2.10 | 1.22 | 1.71 |
| Average age of children under 18 years old | 8.03 | 7.95 | 8.00 |
| Other characteristics (% of all sample farmers): | | | |
| Han | 0.26 | 99.73 | 49.04 |
| Dongxiang ethnic minority | 98.12 | 0.00 | 50.00 |
| Other minorities | 0.00 | 0.00 | 0.00 |
| Are you a village cadre? | 1.55 | 1.25 | 1.40 |
| Are you healthy? | 82.16 | 76.65 | 79.46 |
| Have you ever received nutrition training? | 1.12 | 1.35 | 1.23 |
| Number of family members engaged in the following employment: | | | |
| Farm work | 3.91 | 2.86 | 3.36 |
| Off-farm work | 2.09 | 2.69 | 2.43 |
| Do not work | 2.95 | 2.88 | 2.91 |
| Does the farmer belong to (% **of** all sample farmers): | | | |
| Farmer's cooperative | 3.74 | 6.34 | 5.10 |
| Villagers' self-help organization | 0.00 | 2.20 | 1.15 |
| Has the household received any targeted poverty alleviation supports (% of all sample farming households): | | | |
| Total | 58.02 | 32.44 | 44.64 |
| Subsistence allowance | 24.87 | 11.71 | 17.98 |
| Exceptional poverty allowance | 16.31 | 10.24 | 13.14 |
| Allowance for official registered poor households | 44.92 | 24.15 | 34.06 |

6.2 Table 15 also shows characteristics of sample farmers by treatment status. The P-value instructs the difference between the two group. When P-value is under 0.10, it reflects that the two groups are significantly different at the indicator. The two groups are comparable along several characteristics. For both groups, the average age of farmers who engages in agricultural activities is around 44, and it is roughly balanced in terms of gender. The years of completed education is significantly different between the two groups, with those in comparison group more educated than those in treatment group. Households in treatment group have more children and the average age of the children is older, both are statistically different. The two groups also differ in the number of ethnical minorities, as treatment group includes more sample farmers from Dongxiang county, dominated by ethnical minorities. About 47.13% in treatment group are Han Chinese, while 50.90% are Han in comparison group. There is also significant difference in the participation rate of farmers' cooperative. The number of people who received nutrition training are statistically different between two groups. There are some systematical differences among the two groups. However, health condition and the experience of being a cadre have no difference mathematically. In the evaluation following the endline survey, advance econometric techniques will need to be employed to address this issue. The rates of total poverty condition in two districts have no difference statistically.

Table 15. Characteristics of sample farmer interviewees by treatment status

| | Treatment | Comparison | P-value |
|---|---|---|---|
| Characteristics of the farmer: | | | |
| Age (years) | 44.66 | 43.92 | 0.00 |
| Female (%) | 50.22 | 50.60 | 0.82 |
| Education (years) | 3.68 | 3.61 | 0.00 |
| Characteristics of the farmer household: | | | |
| Family size | 4.84 | 4.61 | 0.00 |
| Number of children | 1.74 | 1.67 | 0.00 |
| Average age of children under 18 years old | 8.03 | 7.96 | 0.83 |
| Other characteristics (% of all sample farmers): | | | |
| Han | 47.13 | 50.90 | 0.00 |
| Dongxiang ethnic minority | 51.02 | 49.01 | 0.00 |
| Other minorities | 0.00 | 0.00 | |
| Are you a cadre? | 1.34 | 1.46 | 0.55 |
| Are f you healthy? | 82.69 | 76.35 | 0.00 |
| Have you ever received nutrition training? | 1.71 | 0.78 | 0.63 |
| Number of family members engaged in the following employment: | | | |
| Farm | 3.22 | 3.50 | 0.00 |
| Off farm | 2.41 | 2.45 | 0.00 |
| Unemployed | 2.99 | 2.81 | 0.70 |
| Does the farmer belong to (% of all sample farmers): | | | |
| Farmer's cooperative | 3.74 | 6.34 | 0.10 |
| Villagers' self-help organization | 0.00 | 2.20 | 0.00 |
| Has the household received any support from any targeted poverty alleviation programs (% of all sample farming households) | | | |
| Total | 44.19 | 45.09 | 0.80 |
| Subsistence allowance | 14.47 | 21.41 | 0.00 |
| Exceptional poverty allowance | 11.11 | 15.11 | 0.01 |
| Are you officially registered poor households? | 36.95 | 31.23 | 0.00 |

6.3 As can been seen in Table 16, the average annual household income of Anding is higher than Dongxiang. **Income from potato production is very low, particularly in Dongxiang.** The main source of household income in Dongxiang is transfer income (47%). This is followed by off-farm income. In contrast, in Anding, the largest share of total income is off-farm income, followed by transfer income and business income.

6.4 For poor farming households, either who accepted subsistence or were officially registered poor households, their average annually income was 47,395 yuan/household, which was lower than non-poor farming household (53,124 yuan/household). The transfer income from government of poor households (21,831 yuan/household) was higher than non-poor (7,464 yuan/household).

Table 16. Household income structure by district

| | Dongxiang | Anding | Total |
|---|---|---|---|
| Total Income (yuan) | 36,728.55 | 62,440.55 | 50,099.8 |
| Income Breakdown (%) | | | |
| Crop income | 1.17 | 2.13 | 1.64 |
| -Potato | 0.11 | 1.20 | 0.71 |
| -Corn | 1.04 | 0.52 | 0.70 |
| -Other crops | 0.02 | 0.40 | 0.23 |
| Livestock Income | 5.03 | 6.62 | 6.07 |
| Business Income[45] | 2.36 | 7.65 | 5.81 |
| Off-farm Income[46] | 44.43 | 66.33 | 58.77 |
| Transfer Income from Government | 47.02 | 17.27 | 27.70 |

6.5 The difference between treatment group and comparison group in potato income was significant. As indicated in Table 17, the share of potato income in total household income for treatment group was 0.38, which was statistically lower than that of control group (1.05).

Table 17. Household income structure by group

| | Treatment | Control | P-value |
|---|---|---|---|
| Total Income (yuan) | 54,544.12 | 45,756.46 | |
| Income Structure (%) | | | |
| Crop income | 1.71 | 1.54 | |
| - Potato | 0.38 | 1.05 | 0.00 |
| - Corn | 1.04 | 0.31 | 0.00 |
| - Other crops | 0.29 | 0.18 | 0.57 |
| Livestock Income | 6.26 | 5.85 | 0.08 |
| Business Income | 6.59 | 4.92 | 0.37 |
| Off-farm Income | 56.71 | 61.18 | 0.00 |
| Transfer Income from Government | 28.73 | 26.51 | 0.01 |

6.6 In Anding, the average size of the total cultivated land per farming household is about 13.65 mu, while it is 5.1 mu for Dongxiang. Meanwhile, Anding also have a larger potato cultivated land of 3.75 mu per farming household compared to 1.65 mu of Dongxiang (Table 18).

6.7 Sample farming households cultivate other crops as well, such as corn, alfalfa and wheat. Sample farming households in Dongxiang planted more corn than potato. There are two reasons for this. First, breeding industry is well developed in Dongxiang. As the feeding crop, the price of corn is higher, and this is especially true in recent years. Farmers cultivated more corn in order to cut feeding cost. Second, it is easy to plant corn than potato since corn doesn't need much field management

[45] Business income: income from running small shop, factory, mill, etc.
[46] Off-farm income: wage/salary from non-farm work

after sowing seed period. In this case, farmers can migrate for non-farming work.

Table 18. Household cropping structure by county/district (mu)

| | Dongxiang | Anding | Total |
|---|---|---|---|
| Total sown area | 5.1 | 13.65 | 8.85 |
| Potato | 1.65 | 3.75 | 2.55 |
| Corn | 2.25 | 3.45 | 2.85 |
| Alfalfa | 0.45 | 0.3 | 0.3 |
| Wheat | 0.45 | 0.75 | 0.6 |
| Flax | 0 | 0.9 | 0.45 |
| Oat | 0 | 0.15 | 0.15 |
| Hyacinth bean | 0 | 0.45 | 0.3 |
| Other crops | 0.3 | 3.9 | 1.65 |

6.8 As seen in Table 19, the difference between treatment group and comparison group in cropping patterns was very small. The mean total land of treatment group was 8.4 mu, which was lower than that of control group (9.3 mu). The mean potato land of treatment group was 2.4 mu, which was lower than that of control group (2.7 mu).

Table 19. Household cropping structure by treatment status (mu)

| | Treatment | Control | P-value |
|---|---|---|---|
| Total sown area | 8.4 | 9.3 | 0.20 |
| Potato | 2.4 | 2.7 | 0.09 |
| Corn | 3.15 | 2.55 | 0.01 |
| Alfalfa | 0.3 | 0.3 | 0.73 |
| Wheat | 0.3 | 1.05 | 0.00 |
| Flax | 0.3 | 0.75 | 0.00 |
| Oat | 0 | 0.15 | 0.14 |
| Hyacinth bean | 0.15 | 0.45 | 0.00 |
| Other crops | 1.8 | 1.35 | 0.54 |

6.9 As can been seen in Table 20, sample farming households also raise livestock. The main types of livestock in Dongxiang are sheep and chicken whereas chicken is the main livestock raised in Anding.

Table 20. Livestock of sample farming households (head)

| | Dongxiang | Anding | Total |
|---|---|---|---|
| Sheep | 24.65 | 17.64 | 22.32 |
| Beef Cattle | 14.60 | 15.60 | 15.07 |
| Pork Pig | 0.00 | 46.39 | 46.39 |
| Piglet | 0.00 | 13.43 | 13.43 |
| Chicken | 23.14 | 67.83 | 61.25 |
| Duck | 0.00 | 29.00 | 29.00 |

| | | | |
|---|---|---|---|
| Donkey | 10.92 | 14.19 | 12.17 |
| Mule | 18.50 | 28.00 | 11.50 |

6.10 Table 21 reveals the usage of potato produced by our sample potato farming households. Anding district can reach the annual production of nearly 1.4 ton/household while annual potato production of Dongxiang was only 0.86 ton/household. The shares of potato quantity used for self-consumption are above 80% and 42% in Dongxiang and Anding, respectively. The shares of potato quantity used for selling purpose are no more than 3% and 32% in Dongxiang and Anding, respectively. As can been seen, the majority of potato produced by our sample potato farming households are self-consumed.

6.11 The producer usually discards about 6.1% to 10.44%. A major reason for loss is due to problems in the soil that cause damage, such as fungi and insects, or rot due to heat and humidity. This is also caused by old storage facility and the appearance demanded by consumers, which causes some of the produced potatoes to be discarded or used as animal feed.

Table 21. Household potato usage (% of total potato production)

| | **Dongxiang** | **Anding** | **Total** |
|---|---|---|---|
| Self-consumption | 81.47 | 42.67 | 64.26 |
| Seed | 4.15 | 16.97 | 9.84 |
| Sold | 2.74 | 31.62 | 15.55 |
| Loss | 10.44 | 6.10 | 8.52 |
| Others (exchange, gift etc) | 1.17 | 2.23 | 1.64 |
| Annual production (ton) | 0.86 | 1.37 | 1.13 |

6.12 As can be seen in Table 22, it reveals that above 90% of sample potato farming households used traditional cellarage for storage of seed potatoes and self-consumed potatoes. In all regions there are no more than 10 constant temperature storages used for potato storage. The average capacity of storage in our sampled area is 2.84 ton. It is also worth noting that the cellar capacity is considerably higher for Anding.

Table 22. Potatoes storage of potato farming household

| | **Dongxiang** | **Anding** | **Total** |
|---|---|---|---|
| Do you have a storage facility? (%) | 91.48 | 90.62 | 91.00 |
| Types of the potato storage (%) | | | |
| Constant temperature storage | 1.29 | 1.62 | 1.44 |
| Over ground | 1.62 | 3.64 | 2.52 |
| Natural ventilation cellar | 4.85 | 3.64 | 4.32 |
| Traditional cellar | 92.23 | 91.09 | 91.73 |
| Storage capacity (ton) | 1.85 | 4.08 | 2.84 |

6.13 According to Gansu Academy of Agricultural Sciences (GAAS), the top three potato varieties with high zinc content in Central Gansu where the project counties are

located are Longshu No. 14, Longshu No. 16, and Longshu No. 11 (Figure 10).

6.14 Most of producers now use virus-free seed potato, which features improved productivity compared to traditional seed potatoes. In sample regions, the top three cultivated varieties are Xindaping, Longshu No. 3 and Zhuangshu No.3. The Xindaping variety offers higher productivity, larger size, and is preferred by consumers for its lighter and smoother appearance. In contrast, Longshu No. 3 variety has higher starch content and it is easy for storage.

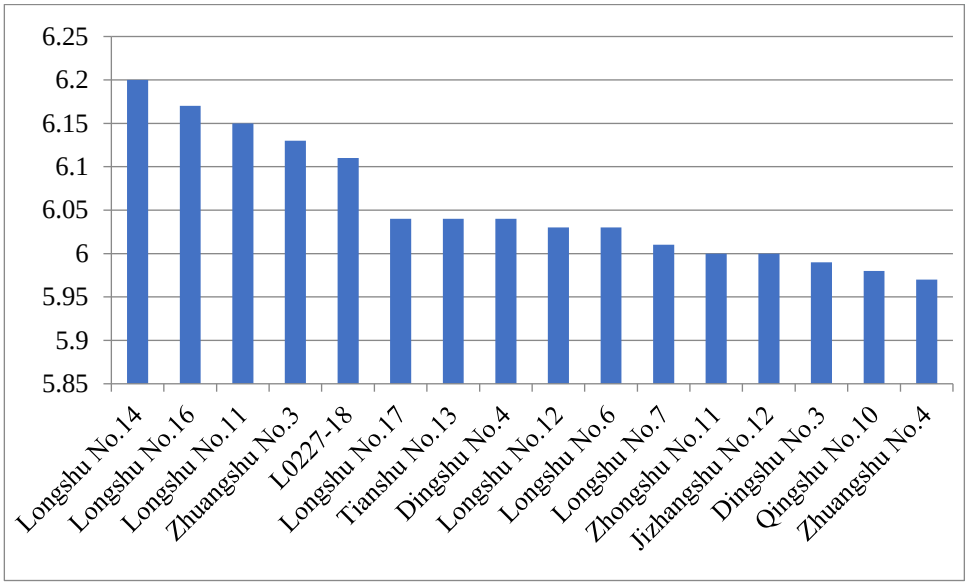



Figure 10. Tuber Zn content in Central Gansu[47]

6.15 It is worth noting that the varieties in the two regions are quite different (Table 23). Sample potato farming households in Anding District are more likely to plant Xindaping (65%) and farmers in Dongxiang County prefer Longshu No. 3 (40%). Neither of the two varieties are high in zinc, according to the GAAS research.

Table 23. Seed potato varieties by county/district
(% of total sample potato farming households)

| | **Dongxiang** | **Anding** | **Total** |
|---|---|---|---|
| Xindaping | 2.09 | 65.19 | 35.56 |
| Longshu NO.3 | 40.17 | 6.67 | 22.40 |
| Zhuangshu NO.3 | 18.82 | 1.30 | 9.53 |
| Qingshu NO.9 | 11.29 | 7.59 | 9.33 |
| Longshu NO.10 | 1.04 | 12.59 | 7.37 |
| Longshu NO.7 | 9.62 | 1.85 | 5.50 |
| Longshu NO.8 | 0 | 1.30 | 0.69 |
| Ailan NO.1 | 1.25 | 0 | 0.59 |
| Heimeiren | 0.83 | 0.37 | 0.59 |
| Qingshu NO.168 | 0.20 | 0.37 | 0.29 |

[47] Gansu Academy of Agricultural Sciences (2020)

| | | | |
|---|---|---|---|
| Ganyin NO.2 | 0.41 | 0 | 0.20 |
| Longshu NO.6 | 0 | 0.37 | 0.20 |
| Ganyin NO.1 | 0 | 0.19 | 0.10 |
| Others | 14.22 | 2.22 | 7.66 |

6.16 **The difference between treatment group and comparison group in potato variety was small (Table 24).** Xindaping and Longshu No. 3 are the top two potato varieties both treatment group and comparison group planted in 2018.

Table 24. Seed potato varieties by treatment status
(% of total sample potato farming households)

| | **Treatment** | **Control** |
|---|---|---|
| Xindaping | 39.92 | 31.58 |
| Longshu NO.3 | 19.55 | 25.00 |
| Longshu NO.7 | 10.29 | 1.13 |
| Zhuangshu NO.3 | 8.64 | 10.34 |
| Qingshu NO.9 | 6.17 | 12.22 |
| Longshu NO.10 | 3.50 | 10.90 |
| Ailan NO.1 | 1.23 | 0 |
| Heimeiren | 0.82 | 0.38 |
| Longshu NO.8 | 0.62 | 0.75 |
| Ganyin NO.2 | 0.41 | 0 |
| Ganyin NO.1 | 0.21 | 0 |
| Qingshu NO.168 | 0.21 | 0.38 |
| Longshu NO.6 | 0 | 0.38 |
| Others | 8.44 | 6.95 |

6.17 When choosing potato seed variety, the top two factors considered are taste (37.93%) and yield (36.53%), followed by whether government distribution for free (12.64%), whether sell well (3.7%) and drought resistant (3.58%) (Table 25).

Table 25. Factors considered by farmers to choose potato seed variety
(% of total sample farmers)

| | **Dongxiang** | **Anding** | **Total** |
|---|---|---|---|
| Taste | 25.47 | 49.27 | 37.93 |
| Yield | 42.09 | 31.46 | 36.53 |
| Government distribution for free | 23.59 | 2.68 | 12.64 |
| Drought resistance | 0.8 | 6.1 | 3.58 |
| Pest tolerance | 0.8 | 0.98 | 0.89 |
| Seed price | 1.88 | 1.95 | 1.92 |
| Good sales | 2.41 | 4.88 | 3.70 |
| Others | 1.61 | 2.2 | 1.92 |

| | | | |
|---|---|---|---|
| Have no idea | 1.34 | 0.49 | 0.89 |

6.18 Our data shows that only 4.48% of sample farmers (35 farmers) were familiar with zinc-enriched potato. The 35 farmers acquired information about zinc-enriched potato mainly through agricultural technical promoter (45.71%, 16 farmers) and villagers or relatives (28.57%, 10 farmers) (Table 26).

Table 26. Channels to receive zinc-enriched potato information (%)

| | **Dongxiang N=11** | **Anding N=24** | **Total N=35** |
|---|---|---|---|
| Agricultural extensionist | 27.27 | 54.17 | 45.71 |
| Agricultural inputs seller | 0.00 | 4.17 | 2.9 |
| TV, broadcast | 9.09 | 0.00 | 2.9 |
| Product brochure | 0.00 | 0.00 | 0.00 |
| Fellow villagers or relatives | 54.55 | 16.67 | 28.57 |
| Others | 9.09 | 25.00 | 20 |

6.19 Among those who familiar with zinc-enriched potato variety, 85.71% of sample farmers want to plant zinc-enriched potato. Table 27 shows the reasons why these farmers would plant if zinc-enriched potato variety were available. The top three reasons were its good taste (46.67%), high yield (26.67%) and health benefit (16.67%).

6.20 For those who are familiar with zinc-enriched potato variety but do not want to plant, they expressed worry about yield and drought resistant of new variety and also stated they had not enough land to plant new variety.

Table 27. Reasons for farmers to choose zinc-enriched potato variety (%)

| | **Dongxiang N=10** | **Anding N=20** | **Total N=30** |
|---|---|---|---|
| Good taste | 50 | 42.86 | 46.67 |
| High yield | 40 | 19.05 | 26.67 |
| Government distribution for free | 0 | 4.76 | 3.33 |
| Drought resistance | 0 | 0 | 0 |
| Pest tolerance | 0 | 0 | 0 |
| Low seed price | 0 | 0 | 0 |
| Good sales | 0 | 4.76 | 3.33 |
| Good for health | 10 | 19.05 | 16.67 |
| Change a new variety | 0 | 9.52 | 3.33 |

6.21 Among those farmers who would plant zinc-enriched potato variety, 73.33% of them were willing to participate in training on agricultural planting techniques. The most popular techniques were potato variety choose (36.36%), land preparation and sowing techniques (27.27%) and pest control technique (22.73%)(Table 28).

Table 28. Preference for zinc-enriched potato training (%)

| | Dongxiang N=7 | Anding N=15 | Total N=22 |
|---|---|---|---|
| How to choose a variety | 71.43 | 18.75 | 36.36 |
| How to deal with seed potato | 0 | 12.5 | 9.09 |
| Land preparation and sowing techniques | 14.29 | 37.5 | 27.27 |
| Irrigation and fertile management | 0 | 6.25 | 4.55 |
| Pest control | 14.29 | 25 | 22.73 |

6.22 Table 29 presents different types of agricultural inputs in both Dongxiang and Anding. Large amount of fertilizer (chemical and manure) are applied in potato planting. Anding's manure usage is larger than that of Dongxiang. Anding potato farming households also applied plastic mulch more.

Table 29. Agricultural inputs

| | Dongxiang | Anding | Total |
|---|---|---|---|
| Potato seed (kg/mu) | 181.89 | 95.66 | 143.39 |
| Chemical fertilizer (kg/mu) | 100.32 | 50.45 | 78.18 |
| Manure (ton/mu) | 0.49 | 0.69 | 0.58 |
| Plastic mulch(roll/mu) | 0.15 | 0.34 | 0.23 |

6.23 In order to acquire more specific information, sample potato farmers were asked to provide detailed planting information about their two largest potato plots. The following analysis is based on these two potato plots.

6.24 As shown in Table 30, the sources of seed potato in Dongxiang County mainly are: a) producers buy seed potatoes; b) seed potatoes that government distributed to them, which is one of means for anti-poverty; and c) producers use potatoes they planted last year or exchanged with other farmers as seed, which is rare.

6.25 However, the sources of seed potato in Anding District are different and producers mainly use potatoes they planted last year as seed. The quantities that they bought, or government distribution are relatively less than Dongxiang County. Farmers in Dongxiang use more seed distributed by local government as a way to fight poverty. Noticeably, during our interview, we found that some farmers in Dongxiang spent more on seed due to governments' late seed distribution in 2018.

Table 30. Potato seed sources by plot of land

| | Anding | | Dongxiang | | Total | |
|---|---|---|---|---|---|---|
| | 1st plot | 2nd plot | 1st plot | 2nd plot | 1st plot | 2nd plot |
| Total seed usage (kg/mu) | 99.62 | 108.24 | 176.34 | 182.97 | 141.59 | 140.80 |
| A) self-reserved | 73.49 | 63.82 | 16.31 | 32.54 | 42.21 | 50.19 |
| B) exchange | 0.23 | 8.09 | 0.23 | 17.63 | 0.23 | 12.25 |
| C) purchased | 15.14 | 20.23 | 81.21 | 72.39 | 51.28 | 42.95 |
| D)government distribution for free | 10.74 | 16.09 | 78.57 | 60.39 | 47.85 | 35.39 |

6.26 As Table 31 shows, potato production in Dongxiang and Anding are still labor-intensive because these are less-mechanized regions. A few households also hire temporary and outsourced labor during harvest season.

Table 31. Labor structure of potato farming household, by plot of land

(workday/mu)

| | Dongxiang | | Anding | | Total | |
|---|---|---|---|---|---|---|
| | 1st plot | 2nd plot | 1st plot | 2nd plot | 1st plot | 2nd plot |
| Family labor | 13.12 | 12.09 | 11.50 | 9.01 | 12.41 | 10.23 |
| Temporary workers | .20 | .21 | .17 | .09 | .19 | .14 |
| Exchange workers | .17 | .19 | .17 | .34 | .17 | .28 |
| Outsourced farming service | .01 | .01 | .06 | 0 | .03 | .01 |

6.27 Table 32 shows irrigation, mechanization and livestock usage of farmers. In sample arid regions, the share of farmers who irrigated potato is no more than 1%. Sample potato farming households also have low technological level, due to the predominance of small producers and the mountainous terrain that hinders mechanized planting and harvesting. The level of mechanization in Anding is higher than Dongxiang, and the top three machinery types are transport machinery, rotary cultivator and tractor. The machinery is mainly family-owned, and the share rented and outsourced is comparatively low. The share of potato farming households used livestock for planting is relatively high since sample districts are located in mountainous terrain.

Table 32. Irrigation, mechanization and livestock usage in the largest two potato farmland of potato farming household, by plot of land

| | Anding | | Dongxiang | | Total | |
|---|---|---|---|---|---|---|
| | 1st plot | 2nd plot | 1st plot | 2nd plot | 1st plot | 2nd plot |
| Irrigation | | | | | | |
| Share of farming households irrigate potato? (%) | 0.78 | 0 | 0.31 | 1.64 | 0.52 | 0.58 |
| Irrigation cost (yuan/mu) | 0.85 | 0 | 0.04 | 0.24 | 0.40 | 0.08 |
| Mechanization | | | | | | |
| Share of farming households use at less one agricultural machinery? (%) | 78.89 | 77.39 | 50.59 | 60.29 | 63.16 | 71.04 |
| Number of machinery worked (workday/mu) | 2.57 | 1.68 | 1.03 | .98 | 1.72 | 1.37 |
| Machinery Type (% of potato farming households) | | | | | | |
| a) Transport machinery | 35.86 | 36.91 | 33.17 | 34.69 | 34.85 | 36.36 |
| b) Rotary cultivator | 34.40 | 30.54 | 14.15 | 8.16 | 26.82 | 25 |
| c) Tractor | 7.58 | 9.40 | 46.34 | 51.02 | 22.08 | 19.70 |
| d) Others | 22.15 | 23.15 | 6.34 | 6.12 | 16.24 | 18.94 |
| Source of Machinery (%of potato farming households) | | | | | | |
| Owned | 71.64 | 82.78 | 33.99 | 47.92 | 57.61 | 74.37 |
| Rented | 22.22 | 12.58 | 55.17 | 39.58 | 34.5 | 19.1 |
| Outsourced | 6.14 | 4.64 | 10.84 | 12.5 | 7.89 | 6.53 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Livestock | | | | | | |
| Share of farming households used livestock for potato planting? (%) | 31.97 | 33.62 | 65.67 | 66.18 | 50.66 | 45.9 |
| Number of livestock worked (workday/mu) | 2.87 | 2.41 | 3.42 | 2.75 | 3.27 | 2.59 |
| Source of livestock (%of potato farming households) | | | | | | |
| Owned | 94.25 | 97.44 | 79.6 | 90.21 | 83.71 | 93.53 |
| Rented | 5.75 | 2.56 | 19.95 | 9.79 | 15.97 | 6.47 |
| Outsourced | 0 | 0 | 0.45 | 0 | 0.32 | 0 |

6.28 Plastic mulch most of producers used is provided by government for anti-poverty. Producers in Anding District are more likely to use plastic and they prefer to use black plastic mulch that features high productivity, low cost and more friendly to the environment. As shown in Table 33, above 50% of producers collected the plastic mulch and took them home after potato harvesting and there are 13%-14% of producers collected them and gave to professional institution. The rest 35% of producers left the plastic in the field, posing potential environmental risks.

6.29 Access to fertilizers and chemicals is generally provided by agricultural inputs store and generally, producers pay for agricultural inputs acquired on spot. Table 33 also shows the fertilizer and chemicals utilization of potato farming households. 50%-60% of farmers thought the soil quality of their potato plots are common. About 95% of farmers use fertilizer and the average use of fertilizer is 60-80kg of fertilize per mu. Farmers used more fertilizer in Dongxiang than those in Anding. However, only 2 farmers apply zinc fertilizer and they purchased zinc fertilizer themselves and foliar application was used. Besides chemical fertilizer, 75%-84% of farmers use farmyard manure and they used 0.7-0.8 tons per mu. During the period of potato planting, application of fungicides and insecticides takes place at 7- or 8-days intervals. There are 40%- 50% of producers in Dongxiang apply pesticides and the share in Anding is about 16% -20%. To save time, some producers apply herbicide to decrease weeds in planting period and the shares are about 30% and 20% in Anding and Dongxiang, respectively.

Table 33. Plastic mulch, fertilizer and chemicals utilization of potato farming household, by plot of land

| | **Anding** | | **Dongxiang** | | **Total** | |
|---|---|---|---|---|---|---|
| | 1st plot | 2nd plot | 1st plot | 2nd plot | 1st plot | 2nd plot |
| Plot area (mu) | 2.53 | 1.88 | 1.32 | 1.02 | 1.86 | 1.56 |
| Self-assessed soil quality | | | | | | |
| Poor soil (% of potato farming households) | 13.75 | 14.04 | 17.26 | 11.76 | 15.70 | 13.19 |
| Common soil (% of potato farming households) | 56.88 | 63.16 | 47.02 | 60.29 | 51.40 | 62.09 |
| Good soil (% of potato farming households) | 29.37 | 22.81 | 35.71 | 27.94 | 32.89 | 24.73 |
| Plastic mulch | | | | | | |
| Share of farming households use plastic mulch? (%) | 32.22 | 32.76 | 7.10 | 8.70 | 18.26 | 23.78 |
| Share of farming households use black plastic mulch in those who use plastic? (%) | 76.74 | 81.58 | 4.17 | 16.67 | 60.91 | 72.73 |
| Share of farming households collect the mulch and take them home after harvesting (%) | 50.60 | 56.76 | 62.50 | 50 | 53.27 | 55.81 |
| Share of farming households collect the plastic mulch and give them to professional institution (%) | 13.25 | 16.22 | 12.50 | 0 | 13.08 | 13.95 |

| | Anding | | Dongxiang | | Total | |
|---|---|---|---|---|---|---|
| | 1st plot | 2nd plot | 1st plot | 2nd plot | 1st plot | 2nd plot |
| Farmyard manure | | | | | | |
| Share of farming households use farmyard manure? (%) | 85.13 | 89.74 | 67.75 | 73.53 | 75.45 | 83.78 |
| Farmyard manure (ton/mu) | .84 | .71 | .7 | .59 | .77 | .67 |
| Zinc fertilizer | | | | | | |
| Number of farming household applied zinc fertilizer | 1 | 1 | 1 | 0 | 1 | 1 |
| Other fertilizer | | | | | | |
| Share of farming households use other fertilizer besides zinc fertilizer? (%) | 90.37 | 94.02 | 97.63 | 100 | 94.41 | 96.22 |
| Amount of fertilizer applied (kg/mu) | 52 | 45.70 | 98.82 | 81.61 | 78.54 | 59.65 |
| Pesticides | | | | | | |
| Share of farming households use pesticides? (%) | 16.04 | 20.87 | 40.65 | 48.48 | 29.75 | 30.94 |
| Pesticides cost (yuan/mu) | 17.07 | 22.34 | 27.24 | 23.04 | 24.81 | 22.74 |
| Share of farming households use herbicide? (%) | 26.87 | 32.46 | 19.64 | 16.67 | 22.85 | 26.26 |
| Herbicide cost (yuan/mu) | 22.94 | 16.96 | 34.31 | 23 | 28.46 | 18.44 |

6.30 Table 34 shows the fertilizers used in potato production. In Dongxiang, 70% potato farming households adopt urea and 20% of them report that the most-used fertilizer is phosphate. Besides, 54% and 24% of potato farming households report the second most-used fertilizer are phosphate and urea. 35% and 17% of them report the third most-used fertilizer are diamines and compound fertilizer.

6.31 In Anding, the most fertilizer used by 46% potato farming households is urea and 24% of them report the most fertilizer they applied is phosphate. Besides, 31% and 27% of potato farming households report the second most fertilizer they applied are urea and diamines. 34% and 28% of potato farming households report the third most fertilizer they applied are urea and diamines.

Table 34. Top 3 fertilizer used in potato production by district

| | Dongxiang | | | Anding | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Top1 | Top2 | Top3 | Top1 | Top2 | Top3 | Top1 | Top2 | Top3 |
| Share of potato farming households use each fertilizer below | | | | | | | | | |
| Urea (%) | 69.3 | 23.61 | 12.2 | 45.87 | 31.03 | 33.33 | 59.37 | 26.78 | 25.23 |
| Diamines (%) | 5.17 | 12.45 | 34.15 | 7.85 | 27.01 | 27.27 | 6.3 | 18.67 | 29.91 |
| Phosphate (%) | 20.36 | 53.22 | 14.63 | 23.97 | 20.69 | 6.06 | 21.89 | 39.31 | 9.35 |
| Compound fertilizer (%) | 4.56 | 8.58 | 17.07 | 5.79 | 4.02 | 7.58 | 5.08 | 6.63 | 11.21 |
| Potato Special fertilizer (%) | 0.3 | 0.86 | 9.76 | 14.46 | 11.49 | 15.15 | 6.3 | 5.41 | 13.08 |
| Potash fertilizer (%) | 0.00 | 0.43 | 2.44 | 0.41 | 0.00 | 0.00 | 0.18 | 0.25 | 0.93 |
| Ammonium carbonate (%) | 0.3 | 0.86 | 9.76 | 1.24 | 5.75 | 7.58 | 0.7 | 2.95 | 8.41 |
| Nitrogen fertilizer (%) | 0.00 | 0.00 | 0.00 | 0.41 | 0.00 | 0.00 | 0.18 | 0.00 | 0.00 |
| Calcium carbonate (%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.52 | 0.00 | 0.00 | 0.93 |
| Triamine (%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.52 | 0.00 | 0.00 | 0.93 |

6.32 Marketing by the producer occurs by different means: a) some harvest and sell to processors (mainly in Anding District), but these are rare; b) some sell to individual consumers or co-operatives, these are also rare; or c) some sell to intermediaries including agents and wholesalers who will market the potato. Above 70% of the farmers who sold their potatoes via brokers or intermediate due to the higher price (20.13%) or short distance (26.84%).

6.33 Table 35 shows the potato marketing information. Only less than 6% of potato farming households sold potato in Dongxiang County, and above 51% in Anding District. In general, most farmers only sold potato no more than 2 times. The possible reasons are as follows: a) farmers consume a lot potato due to local dietary habit. Local people eat potatoes every day, even every meal; b) both sample areas are in mountainous region and traffic facilities are poor, it is hard to transport out the potatoes; c) the breeding industry is developed, especially in Dongxiang County. Due to low potato price, farmers tended to take small potato or excess potato as feed for cow and sheep.

6.34 In average, 83% of potato farming households sold potatoes just after digging out or several weeks later after digging out. And 17% of farmers sold after storage. The primary reason that they did not store is that they need money.

6.35 The main destinations for potatoes from the regions visited are inside the local county. The potatoes were sold inside the county market (around 99%).

6.36 Most of the transportation is done by the seller, on average this amount reaches 59%. The average transport distance is nearly 10 KM and the transportation cost is above 82 Yuan in average. In addition to transportation cost, farmers also need to pay other 77 Yuan for packing, weighing, loading and unloading, etc. The whole potato transaction will take nearly 5 hours.

6.37 All the potato transactions are in cash payment and only 5% of payments are deferred and the deferred payment period in less than 3 days. Most potatoes are marketed through an intermediary including brokers and wholesalers. The pricing varies significantly, depending on whether or not there is a long-term relationship between producer and other factors.

6.38 Various forms of marketing potatoes via intermediaries were found. The first is when the intermediary introduces potato buyers to farmers and intermediary will get commission payments. A second form is the broker buys the potato from the growers and pays cash, and then they sell to wholesalers. The third form is that some farmers sell potato to potato co-operatives at a higher price who usually have a higher requirement on potato variety, size and appearance.

Table 35. Characteristics for potato selling

| | **Dongxiang** | **Anding** | **Total** |
|---|---|---|---|
| | n=338 | n=270 | n=608 |
| Do you sell potato (% of total potato farming households) | 5.62 | 51.11 | 25.99 |
| Number of potato selling transaction | 1 | 1.31 | 1.27 |
| **Potato selling characteristics** | n=20 | n=138 | n=158 |

| | | | |
|---|---|---|---|
| Potato selling timing (% of total potato farming households who sold potato) | | | |
| Immediately after harvest | 60 | 81.02 | 78.34 |
| Several weeks later after being harvested | 5 | 5.11 | 5.1 |
| After storage | 35 | 13.87 | 16.56 |
| Potato buyers (% of total potato farming households who sold potato) | | | |
| Brokers | 5 | 7.25 | 6.96 |
| Local wholesalers | 80 | 55.8 | 58.86 |
| Potato processors | 0 | 14.49 | 12.66 |
| Others | 15 | 22.46 | 21.52 |
| Destination of the potato sold (%of total potato farming households who sold potato) | | | |
| Local (this village) | 10 | 38.41 | 34.81 |
| Other villages in this town | 35 | 47.1 | 45.57 |
| Other town in this county | 55 | 13.77 | 18.99 |
| Outside the county | 0 | 0.72 | 0.63 |
| Payment | | | |
| Share of farmers get cash payment (%) | 100 | 100 | 100 |
| Share of farmers who have deferred payment (%) | 5 | 5.07 | 5.06 |
| Deferred payment period (number of days) | 1 | 2.83 | 2.57 |
| Transportation | | | |
| Distance from farm gate to market (km) | 16.81 | 8.95 | 9.95 |
| Share of farmers responsible for transportation (%) | 70 | 57.25 | 58.86 |
| Transport cost (yuan) | 65.33 | 85.21 | 82 |
| Other cost besides transport (yuan) | 11.6 | 86.98 | 77.25 |
| Transaction time (hour) | 3.2 | 5.01 | 4.78 |

6.39 The average yield is 0.59 tons of potatoes per mu in 2018. Potato is sold for an average of 0.75 yuan /kg in 2018. Compared to other areas, such as Inner Mongolia, the potato yield in the region is relatively low due to lack of irrigation and low technology. In 2018, potato price is 0.94 Yuan/kg and 0.72 Yuan/kg in Dongxiang County and Anding District, respectively (Table 356)

Table 36. Potato production, loss and sales of farming household

| | **Anding** | **Dongxiang** | **Total** |
|---|---|---|---|
| Potato yield (ton/mu) | 0.53 | 0.65 | 0.59 |
| Selling price (yuan/kg) | 0.72 | 0.94 | 0.75 |
| Selling quantity (kg) | 978.27 | 40.92 | 456.83 |

6.40 The potato yield of Dongxiang (0.65 ton/mu) is higher than Anding (0.53 ton/mu), which is consistent with the secondary data reported from Bureau of Statistics of Gansu province, which indicated the potato yield of Dongxiang was higher than Anding from 2011 to 2017, except for 2013 and 2015 [48](Table 37).

[48] Retrieved at: http://tjj.gansu.gov.cn/HdApp/HdBas/HdClsContentMain.asp?ClassId=70

Table 37. Potato yield in Anding and Dongxiang in 2011-2017(ton/mu)

| Year | **Anding** | **Dongxiang** |
|---|---|---|
| 2011 | 0.88 | 0.94 |
| 2012 | 0.95 | 0.99 |
| 2013 | 1.16 | 1.06 |
| 2014 | 1.03 | 1.1 |
| 2015 | 1.09 | 0.93 |
| 2016 | 0.98 | 1.18 |
| 2017 | 1.07 | 1.38 |

6.41 However, the potato yield in 2018 is much lower than previous years due to disasters suffered by farmers. As we can see from Table 38, 62% of Dongxiang potato farming households and 43% of Anding potato farming households suffered disasters include too much rain, drought, diseases and insect pests, etc. in 2018, which lead to a sharp drop in production. There were even 4 potato farming households reaped nothing at harvest time.

Table 38. Disasters suffered by potato farming household in 2018 (%)

| | **Dongxiang** | **Anding** | **Total** |
|---|---|---|---|
| No disaster | 37.98 | 56.72 | 46.28 |
| Too much rain | 52.52 | 16.42 | 36.53 |
| Drought | 2.97 | 13.43 | 7.6 |
| Potato late blight epidemic | 0.3 | 1.49 | 0.83 |
| Diseases and pests | 3.56 | 5.97 | 4.63 |
| Other weather disasters | 1.78 | 4.1 | 2.81 |
| Potato damage caused by animal | 0.59 | 0.75 | 0.66 |
| Others | 0.3 | 1.12 | 0.66 |

6.42 Table 39 shows the potato production costs of potato farming household. On average, potato production cost is around 351.97 yuan per mu since most of sample potato farming households are small producers and they produce potato just for self-consumption that they invested less, such as fertilizer, labor and pesticides and so on. Besides, local government distributed lots of agricultural inputs such as seed potato, plastic to farmers as part of local anti-poverty policy.

6.43 The production costs vary considerably, with the farmers of Dongxiang declare a higher production cost of 452.32 yuan per mu while farmers in Anding declare a lower production cost of 226.34 yuan per mu. The possible reason why there is big difference between the two districts may be farmers use more seed and fertilizer in Dongxiang. Though government distributed potato seed for free, some farmers in Dongxiang stated that they have to purchase seed since it was too late to sow with seed government distributed.

6.44 The farmers declared that fertilizer had higher share in the production cost, followed by seed potato, machinery service, transport and energy cost.

Table 39. Potato production costs of potato farming household

| | Anding | Dongxiang | Total |
|---|---|---|---|
| Total potato production cost (yuan/mu) | 226.34 | 452.32 | 351.97 |
| Labor (%) | 0.38 | 0.09 | 0.2 |
| Manure (%) | 1.53 | 0.21 | 0.8 |
| Plastic (%) | 11.7 | 1.5 | 6.03 |
| Irrigation (%) | 0.09 | 0.05 | 0.07 |
| Seed potato (%) | 8.76 | 31.67 | 21.49 |
| Fertilizer (%) | 50.16 | 53.23 | 51.86 |
| Pesticide/Herbicide (%) | 4.41 | 4.61 | 4.51 |
| Machinery service (%) | 8.63 | 5.86 | 7.09 |
| Transport, energy cost and others (%) | 14.3 | 2.75 | 7.88 |

## 6.45 Key findings of potato farming

- Sample faming households are small producers that plant 2.55 mu of potatoes on average. The area allocated to potato production in 2018 represented 28% of their total sown area. The share of corn (32%) was a little higher than potato.
- The average yield is 0.59 ton of potatoes per mu, whose production cost is around 351.97 yuan, namely 595 yuan/ton of potato. The cost is lower than other potato-producing regions, such as Inner Mongolia and Hebei because of the following factors: increase of seed potatoes and plastic that government distribution; decrease of labor input due to extensive management; low input in the machinery due to mountainous and terraced fields.
- The Xindaping variety is the most cultivated in Anding, while Longshu No. 3 variety is the most cultivated in Dongxiang. Neither the two varieties is high in zinc.
- 80% of potato farming households used farmyard manure and they used nearly 0.58 tons per mu. Nearly all farmers used fertilizer and the most fertilizer used by farmers are urea and phosphate. However, the share of farmers use zinc fertilizer is considerably low (only 2 farmers).
- Though the irrigation is an important technology for potato production, few potato producers use irrigation both in Anding and Dongxiang.
- Plastic mulch that most producers used is provided by government for anti-poverty. Producers in Anding District are more likely to use plastic and they prefer to use black plastic that features high productivity, low cost and environmentally friendly.
- The baseline study found half of producers in Dongxiang applied fungicides and insecticides and the share in Anding is below 20%. To save time, some producers apply herbicide to decrease weeds in planting period and the shares are no more than 30% in Anding and Dongxiang, respectively.
- The majority of potato production of the surveyed area relied on family labor. For

one, most sample potato farming households are small producers and they produce potatoes just for self-consumption. For another, as the sample areas are mountainous and terraced fields, the level of mechanization of the potato production is low and therefore more labor-intensive.

- Sample farmers have a low cognition on zinc-enriched potato variety and the access to potato variety information is limited. Only 4.48% of farmers (35 farmers) have heard of the variety and 30 of the 35 farmers would plant zinc-enriched potato if the variety were available.
- When choosing potato seed variety, sample farmers gave highest priority to taste since 80% and 42% of potato farming households produced are self-consumed, followed by yield and whether government distributes them for free.
- Both the share of farmers selling potato and potato sales quantity are low. Farmers in Anding are more likely to sell potato than those in Dongxiang. Furthermore, the shares of potato sold of their total production are only 3% in Dongxiang and 32% in Anding.
- The household income of farmers mainly comes from transfer income from government, especially in Dongxiang. This is because sample districts are state-level poverty-stricken county. The income from agriculture is considerably low, especially in Dongxiang. Specially, income from potato represents 0.11% and 1.8% of household income in Dongxiang and Anding, respectively.

## 7. Local potato aggregator

7.1 We interviewed three wholesalers/brokers from Wangji and Suonan township in Dongxiang.

7.2 Mr. Ma is a wholesaler and a director of potato cooperative in Wangji township. The cooperative was founded in 2011. With more and more rural households migrated to work in sweater- or tea- producing factories, there were 120 rural households have joined cooperatives by 2019, and 40 of which were in poverty.

7.3 In 2018, the cooperative planted 90 mu of potato and 80 mu of corn. The two potato varieties are Longshu No.10 with strong drought resistance and Longshu No.7 with good shape. Small mechanical tillage is used for potato land preparation since the terrain here is terraced. Farmers have been employed during harvest with wage of 120 yuan/day.

7.4 In addition to potatoes produced by the cooperative, Mr. Ma also purchased potatoes from local small farmers to sell outside of Dongxiang county. The potatoes of lager size were sold to wholesalers outside and the smaller ones were sold to starch processing plant.

7.5 Potato price fell from 3 yuan/kg five years ago to 1.4 yuan/kg in 2018, combined with the rapid development of livestock industry, cooperative has increased the production scale of corn.

7.6 There is another Mr. Ma, a director of another potato cooperative in Suonan township. He also was also a broker and a wholesaler. With financial support from Lanzhou Potato Association and loans from Postal Savings Bank of China,

Agricultural Bank of China and Chinese Rural Credit Cooperatives, his potato cooperative built storage facility for potato in 2013. However, potato loss is about 20% to 30% due to evaporation, decay, exfoliation of epidermal soil, and mechanical harvest damage.

7.7 From every December to March of next year, he bought potatoes not only from members of potato cooperative but also from local farmers in order to sell to Changsha, Guangzhou, Chengdu and Xinjiang through wholesalers outside Gansu. In 2018, Mr. Ma sold 1,000 tons of potatoes at the price of 2.4 yuan per kilogram through wholesalers outside Gansu. The potato varieties focus on Long No.7, Long No.12 and Jizhang No.12. The marketing costs were comprised from transport cost 0.4 yuan/kg, labor cost for packaging, sorting and loading and unloading 0.2 yuan/kg, packing bag/box cost 0.2-0.5 yuan/kg.

7.8 Mr. Huang, as a potato broker, is also a director of the potato cooperative in Dongxiang county. The potato cooperative was founded in 2015, with 175 potato households and an area of 3,000 mu. In 2018, 125 households planted 1,200 mu of potatoes, mainly Longshu 7# and Zhuangshu 3#, which feature high yield and high starch content and another 50 households plant corn for crop rotation.

7.9 The cooperative signed a contract with an agricultural company and produces seed potatoes according to the contract. The agricultural company has the priority to repurchase the seed potato after harvest. The share of seed potato bought by the agricultural company is about 60% and they mainly sold them to Sichuan, Yunnan, Guangdong and Gansu. The remaining 40% is sold to local potato farmers and local government as part of the poverty alleviation policy.

7.10 The cooperative also produced common potato, the yield is about 1.5 to 2 tons per mu. Note that this is substantially higher than what we have showed above for our sample area. The possible reasons are as follows. First, cooperative applied more fertilizer at different stages of potato growth; Second, the cooperative stated they are better at pest control than farmers and this is very important for increasing production. The potatoes Mr. Huang sold mainly come from cooperative members and other local farmers from every November to April of next year. The volumes were 1,000 tons and 800 tons per month during the peak season and the low season. In 2018, Mr. Huang sold 50 tons potato at the price of 2.8 yuan/kg to ShengLi Oil Field in Shandong province, which was contacted by the local poverty alleviation leader from Sinopec Group. The cost of packaging, sorting and transportation was 0.8 yuan/kg.

7.11 He also sold potato to local government, Sichuan and Country Garden Holdings in Guangdong. Besides, he also sold potato to canteen in Lanzhou and wholesalers outside Linxia at the price of 1.6-1.8 yuan/kg. In order to sell out the potato, Mr. Huang also sold as a retailer in Linxia at the price of 2 yuan/kg. The transport cost varied according to distance and transport volume.

7.12 The level of mechanization was higher than small farmer households. Machineries were used from tilling, sowing to harvesting, including sowing film fertilization machine, micro-tiller, rotary tiller, seeder, earth clamping machine and machine for crushing potato seedlings.

Table 40. Potato production cost of cooperative

| | | Quantity(yuan/mu) | Share (%) |
|---|---|---|---|
| Total cost | | 2,510 | |
| Land rental | | 250 | 9.96 |
| Labor | | 1,000 | 39.84 |
| Machinery | Ploughing | 50 | 1.99 |
| | Sowing | 150 | 5.98 |
| | Covering soil | 50 | 1.99 |
| | Harvesting | 150 | 5.98 |
| | Crushing potato seedlings | 50 | 1.99 |
| Pesticides | | 50 | 1.99 |
| Fertilizer | | 300 | 11.95 |
| Seed | | 390 | 15.54 |
| Plastic mulch | | 70 | 2.79 |

7.13 They applied fertilize twice during potato growing season. They applied farmyard manure and chemical fertilizer before sowing and then apply potato special fertilizer, which was done by unmanned aerial vehicle. Pesticides were mainly used for controlling late blight and aphid.

7.14 The production cost was about 2,510 yuan per mu. The cooperative declared that labor constituted the largest share in the production cost, followed by machinery, seed potato, and fertilizer.

7.15 With the help of local government, the cooperative borrowed storage for free to store potato because it was too high to build storage facility themselves. Mr. Huang said potato loss was around 50% due to evaporation, decay, and meeting consumers' appearance requirements.

# VI. Conclusion and Recommendation

## 1. The scope of zinc deficiency among sample children

1.1 Although there is no consensus on appropriate biochemical indicators of body zinc status, the baseline team adopted serum zinc, hair zinc, and dietary zinc intake as three indicators. Given the tremendous challenges caused by blood phobia and the local cooperation issues in Dongxiang, the team had to cancel the venous blood collection there. Also considering that age-specific serum zinc cutoff has yet been defined in China, as well as unexpected contamination of blood sample, the team focused on hair and dietary indicators instead.

1.2 Results from hair and dietary zinc tests showed consistency between the two indicators, indicating that 20.22% sample children had low hair zinc level (the most prevalent malnutrition in the surveyed area), while 21.3% and 21.71% children could not reach the estimated average requirement (EAR) and the recommended nutrient intake (RNI) of zinc. Since both hair zinc and dietary intake reflect long-term zinc status, the results could to some extent reveal the scope of zinc deficiency among sample children. Compared with the zinc deficiency rate among rural Chinese children in 2012 (10.4%)[49], **these findings revealed that a significant number of children do face the challenge of zinc deficiency and need interventions to address this challenge.**

1.3 The baseline data also presented higher risk of zinc deficiency among certain sub-groups of children. The prevalence of zinc deficiency was alarmingly high among tested preschoolers (38.27%). Dongxiang Ethnicity Autonomous County faced greater challenge than Anding District, dominated by Han Chinese. Girls also had higher rate of zinc deficiency, though not significantly different from their boy counterparts. **The project can consider designing Dongxiang- and female-oriented interventions given their vulnerabilities**. Besides, **it is highly recommended that future project interventions can cover preschoolers and their families in Dashu and Lujiagou as well** (currently there are only primary school students in grades 1-3 in the treatment group).

## 2. Other nutrition and developmental performance of sample children

2.1 The baseline findings also indicated that a significant number of children lacked iron and thus might suffer from iron-deficiency anemia. **As such, the project's nutrition educational campaign should not only focus on zinc but also other micronutrients such as iron. It is suggested to promote a balanced diet based on the Chinese dietary guidelines**.

2.2 Comparing with national level, progress could still be made to reduce undernutrition among sample children in the study area. Particularly, the prevalence of stunting and wasting are considered medium based on the WHO cut-off for public health significance. Children from Dongxiang County suffered from higher rates of malnutrition compared with their counterparts in Anding. Primary

[49]Liu, X., Piao, J., Zhang, Y., He, Y., Li, W., Yang, L., & Yang, X. (2017). Assessment of Zinc Status in School-Age Children from Rural Areas in China Nutrition and Health Survey 2002 and 2012. *Biological trace element research*, *178*(2), 194-200.

school students were in worse situation in terms of stunting and underweight compared with preschoolers. Cognition delay and the rate of poor academic performance were alarmingly high among sample children, especially for ethnic minorities in Dongxiang County. **It is thus expected that the project can pay attention to these nutrition and developmental indicators as well and channel more resources into this region.**

3. **Zinc knowledge:** Most caregivers interviewed in the baseline survey lacked relevant zinc nutrition knowledge, with grandparents of children and female caregivers scoring even lower. **There is an urgent need to implement behavior change communications (BCC) activities regarding zinc as an important micronutrient in human body and zinc deficiency. Upcoming education activities can also be designed to better target at grandparents and female caregivers**. A balanced diet is important to enhance nutritional status of local families. Although the main target of the project is families with students from grades 1-3, it can benefit more households in the same school by listing them as the audiences of education campaigns.

4. **Zinc-enriched potato cultivation**

4.1 Potato is found to be the main staple food and also the second largest source for zinc intake in the region. Meanwhile, potato varieties grown in the region are not necessarily rich in zinc. **As such promoting zinc-enriched potato varieties to the farmer households might be an effective way to enhance the zinc-intake. To promote zinc-enriched potato variety, the project needs to consider the taste/flavor of potato as a large share of potatoes are consumed at home. Other factors that are important to consider are drought tolerance and high yield in order to increase local adaptability of zinc-enriched potatoes**. As a large share of seed potato, particularly at Dongxiang, were provided by the government as a support, **it would be very useful to enhance zinc-intake if the government agency can select the potato varieties that are rich in zinc for its distribution**.

4.2 Though large amount of fertilizer was applied in the potato production in the region, only 2 farmers reported that they had applied zinc fertilizer before, and 35 farmers heard about the zinc-enriched potato. Majority of farmers had no knowledge of zinc-fertilizer. In order to fully tap the potential of zinc-fertilizer in increasing the zinc content of potato, **it is important to provide targeted technical guidance to introduce zinc fertilizer in the project area**.

5. Farmers in the region derived large share of their income from government support and nonfarm activities. Incomes from agricultural and livestock activities are small. Moreover, less than 1% of their income is from potato farming. Corn, sheep, and beef cattle are more important income generating activities for local farmers than potato. Moreover, majority of potato were self-consumed. As a result, **potato would only play a very limited role on increasing farmers' total income on average. The project needs to rethink its strategy to boost beneficiaries' income through potato cultivation and marketing, especially for Dongxiang farmers who are in deeper poverty**. However, **the project may consider working with farmers' cooperatives and new generation of farmers to**

**increase their incomes through increasing specialization in potato farming, particularly at Anding**. To boost income from potato farming, **it is critical if local potato such as zinc-enriched potato can be branded to command a premium price in the marketplace**.

6. The baseline survey also indicated a huge difference between farmers and potato farming activities at Dongxiang and Anding. As such to make the project more effective, **it is wise to consider differential strategy and interventions in the two counties**.
7. As the baseline survey contained rich information on nutrition and potato farming, it is suggested that the project management and design teams to take a close look and use the information from the baseline survey to check appropriateness of currently designed interventions.

## Annex A Project Background

1. **Subject of the baseline study:** Gansu Smallholder Farmers Growing Zinc-enriched Potatoes Pilot Project

2. **Geographic scope and time frame**

- The project is implemented in Anding District of Dingxi City and Dongxiang County of Linxia Hui Autonomous Prefecture, Gansu Province of China. Both of them are national-level poverty counties. Specifically, a township in each county/district is covered, namely Lujiagou in Anding and Dashu in Dongxiang.
- The project was launched on October 22, 2019 and will last until 2023.

3. **Project goal and objectives**[50]

- Goal: contribute to the achievement of SDG 2: Zero Hunger, and the national target of nutrition improvement and poverty reduction as outlined in the China's *13th Five-Year Plan (2016-2020)* and China's *National Food and Nutrition Plan (2014-2020)*.
- Objective 1: increase availability of zinc-enriched potatoes in poor, rural Gansu where the prevalence of zinc deficiency is high.
- Objective 2: increase smallholder farmers' income and hence break the cycle of poverty through enhanced capacity of the targeted, poor, smallholder potato farmers in Gansu across the value chain.
- Objective 3: document the impact of this initiative for potential replication/upscaling.

4. **Project beneficiaries**

- The project will adopt a group and individual targeting strategy. All students in grade 1 to 3 in the central primary schools of Lujiagou Township of Anding and Dashu Township in Dongxiang is targeted. The school enrolment register will help map out student families that grow potato or are willing to do so. This group of farming household will be supported by the project.
- Individual targeting focuses on poor and vulnerable farmer households with economically active family members. The county and township poverty data will guide the implementing agencies and the Project Management Office (PMO) to accurately target beneficiaries.
- On average, the project will support 2 mu of zinc-enriched potato production for each farmer household.
- Once a household starts zinc-enriched potato production, the project will maintain the same level of support to the same household until the completion of the project. According to the estimation of the project design, a total number of 3,150 farming households will be benefit from project intervention with potato production area of 6,300 mu. The targeting and implementation phasing are given in Table 41 as below:

[50]As presented in the project design document

Table 41. Household targeting and phasing

| Year | 2020 | 2021 | 2022 | 2023 | Total |
|---|---|---|---|---|---|
| Farmer households | 850 | 1,850 | 3,150 | 1,150 | 3,150 |
| – School targeting | 250 | 250 | 250 | 250 | 250 |
| – Individual targeting | 600 | 1,600 | 2,900 | 900 | 2,900 |
| Area (mu) | 1,700 | 3,700 | 6,300 | 2,300 | 6,300 |

## 5. Main partners

- The project is funded by Teck Resources Limited. As one of the world's largest producers of zinc, Teck is committed to helping solve the global health challenge of zinc deficiency.
- Agricultural agencies at central-, provincial-, county-, and township-level, particularly the Ministry of Agricultural and Rural Affairs (MARA) and the Gansu Department of Agricultural and Rural Affairs, are partners in the design and implementation of the project.
- The project is technically supported by the National Agro-tech Extension Centre (NATEC), an integrated agricultural technology extension organization in China. NATEC commands the resources of more than 400,000 agricultural extension workers from the national to the village level.
- An external technical advisory group has been established to bring about broad international expertise and forge strategic partnership. Expertise is drawn from International Potato Centre (CIP), the Institute of Food and Nutrition Development of MARA (IFND), the Institute of Vegetables and Flowers of the Chinese Academy of Agricultural Sciences (CAAS), the Biotechnology Research Institute of CAAS, Chinese Center for Disease Control and Prevention(CDC), International Food Policy Research Institute (IFPRI) and United Nations International Children's Emergency Fund(UNICEF).

## Annex B Training of nurses and enumerators

1. The training of enumerators who were responsible for household survey was conducted by Dr. Chengfang Liu from Peking University and Dr. Zihan Li from Langfang Normal University. Enumerator training was organized in two parts. The first part was focused on the conceptual aspects of all the questionnaires, module by module. Enumerators responsible for household dietary survey were trained by Ms. Yunyi Zhou from IFPRI Beijing Office and Dr. Shopping Li from Peking University.
2. Dr. Chengfang Liu, as a licensed trainer of the Chinese version of the fourth edition of the Wechsler Preschool and Primary Scale of Intelligence (WPPSI-IV) and the Wechsler Intelligence Scale for Children (WISC-IV), also administered the technical training of cognition test. Qualified enumerators who passed the final exam organized by Dr. Liu acted as cognition examiners in the field.
3. Communication skills and ethical considerations were on the training agenda as well to ensure a smooth, safe, and respectful survey procedure. Followed the indoor training was the field testing in nearby village and a rural preschool, during which enumerators and cognition examiners tested and reinforced what they learnt in training as well as in detected any remaining errors or typos in the questionnaire.
4. 5 registered nurses from local hospital who were highly experienced in venous blood test were invited by the local government to join the study. They were trained by Ms. Ling Liu, head pediatric nurse at Lanzhou University NO.1 Hospital. 10 enumerators with medical background were selected and trained by Dr. Jinhui Fan from the Civil Aviation General Hospital to take anthropometric measurements (height and weight) and collect hair samples. Those enumerators also attended field test as a chance to get familiar with equipment, test procedure, and ethical considerations.

## Annex C Baseline data collection: household and dietary survey

1. Household survey enumerators started their work by guiding their interviewees to learn about basic information about the questionnaire survey, physical examination, and cognitive test. To protect the rights and welfare of children, their caregivers were responsible for deciding whether the children would participate and completing the informed consent form. With interviewees being fully aware of the survey procedure and their own rights, the enumerators then completed required questionnaires for caregivers and school/preschool staff. All the questionnaires were carefully signed, dated, collected, and carefully double checked and preserved at the end of the day.
2. Food consumption is closely associated with nutritional deficiencies. Inadequate intake of zinc is by far the most likely cause of zinc deficiency for people living in developing countries. This is because most diets in developing countries have a very low bioavailability of zinc, and at the same time poor sanitation and hygiene generate a high prevalence of recurrent infections such as diarrhea that increase the requirements for zinc. Food items which contain plentiful of zinc include meat (especially liver), seafood and eggs, all of which are relatively expensive and thus lacking in many diets.
3. Studies show that nutritional deficiencies of iron and zinc are often widespread in developing countries, where staple diets are frequently plant-based and consumption of expensive flesh foods (i.e., red meat, poultry, and fish) is low. This is also true for rural China, especially in rural Gansu.
4. For assessing micronutrient intake, standard dietary assessment methods are used, such as weighted food records, recall questionnaires or semi-quantitative food frequency questionnaires. As zinc is present in many food items, semi-quantitative food frequency questionnaires (FFQ) might be less accurate, as only a selected number of food items are covered. A major drawback of dietary assessment methods is that although national food composition tables with data of local food items are sometimes (but not always) available, these are often incomplete or inaccurate.
5. To make benefit of the above methods, in this baseline survey, semi-quantitative food frequency questionnaires (FFQ) were used for all sample children and their mother, while the method of weighted food records was also used for subsample children in the 296 households.
6. FFQ asks respondents how often and how much food they ate in the past month. Presenting 75 foods (those are often consumed in local areas and zinc-enriched), this questionnaire takes 20-30 minutes to complete.
7. 2-day 24-hour diet recall of detailed household food intake information was collected. Household food intake was determined on a daily basis by calculating the changes in food inventory. All foods and condiments in home inventory, purchased from markets, picked from gardens and food waste were carefully recorded and measured at the start and end of each survey. In addition, individual dietary intake for two consecutive days was collected for every household member. Food items consumed at restaurants, canteens and other locations away from home were systematically recorded. Using food models and pictures, trained field interviewers recorded the amounts of all foods

consumed during 24 h of the previous day.

8. The Estimated Average Requirement (EAR) is the amount of a nutrient that is estimated to meet the requirement for a specific criterion of adequacy of half of the healthy individuals of a specific age, sex, and life-stage. In setting the EAR, the evidence for each possible criterion is considered, and the reason for selecting the criterion that is finally chosen is justified. The amount of the nutrient necessary to meet the appropriate criterion of adequacy varies from one individual to the next, but the data are usually distributed normally or can be transformed to achieve a normal distribution. The EAR is not useful as an estimate of nutrient adequacy in individuals, because it is a mean requirement for a group, and the variation around this number is considerable. At the EAR, 50% of the individuals in a group are below their requirement, and 50% are above it. Thus, a person whose usual intake is at the EAR has a 50% risk of an inadequate intake during the reporting period. An individual with an intake between the RNI and the EAR would have a risk of inadequacy between 50% and 2–3%. An individual with a usual intake below the EAR would have a risk of inadequacy between 50 and 100%. This is because the EAR is derived from a group estimate. The precise amount of a nutrient that will be adequate for any given individual is therefore unknown. It can be stated only in terms of probabilities, and thus it is rarely used in clinical practice. For healthy individuals whose usual nutrient intakes are accurately described, the EAR can be used to assess the approximate probability of inadequacy, although the range of error in the estimate is considerable.
9. The Recommended Nutrient Intake (RNI) is based on the population for which the mean and standard deviation were determined. Thus, different populations (children, men, women, etc.) have different RNIs. For nutrients where the data are insufficient, experts make a guess based on what appear to be typical intakes of healthy-seeming people.
10. EAR and RNI are very different among different countries. For China, we also have the Chinese dietary reference intakes. So we can find the EARs and RNIs for different people with a specific age and sex, which means that the absolute level of zinc or iron intake is not very useful, so we should also use the proportion of people do not meet the need of EAR or RNI to identify the problem of zinc or iron deficiency among people.

Table 42. The intake level of zinc and the gap between EAR and RNI (mg/d)

| Age group | Intake of zinc | EAR | Gap between intake and EAR | RNI | Gap between intake and RNI |
|---|---|---|---|---|---|
| 2--3 | 1.8 | 3.2 | 1.4 | 4 | 2.2 |
| 4--6 | 2.3 | 4.6 | 2.3 | 5.5 | 3.2 |
| 7--10 | 3.4 | 5.9 | 2.5 | 7 | 3.6 |
| 11—13, boys | 4.5 | 8.2 | 3.7 | 10 | 5.5 |
| 11-13, girls | 5.8 | 7.6 | 1.8 | 9 | 3.2 |
| 14-16, boys | 6.9 | 9.7 | 2.8 | 12 | 5.1 |
| 14-16, girls | 5.3 | 6.9 | 1.6 | 8.5 | 3.2 |

## Annex D Baseline data collection: child hair and serum zinc test

1. Trained enumerators collected hair samples with stainless steel scissors from the occipitonasal region of the child's head, within 3 cm of the hair line. All the sample students and children were asked to carefully wash their heads the night before physical examination. Before cutting hair, the enumerator would ask whether the child had washed his/her head, whether he/she had any recent head injury, and whether he/she colored or permed hair recently. Hair sample would not be taken if any of the answers was yes. All hair samples were stored in chemical-free, polypropylene containers and send to lab in the Civil Aviation General Hospital for analysis. Samples were washed with acetone, water, and HNO3. The purpose of washing was to remove foreign materials, including oil and exogenous metals. After samples were washed, they were cut into small pieces with surgical scissors and dissolved in preconditioned acidic tube. The hair solution was analyzed by a PinAAcle 900T Atomic Absorption Spectrometer. Hair zinc level was reported in μg/g.
2. 3 ml fasting morning blood samples were taken from the vein in the child's antecubital fossa between 8 am and 10 am for biochemical assessment of serum zinc. Professional nurses were responsible for blood collection in cooperation. One of them had a firm comfortable hold of the child and immobilized the arm to be punctured, to prevent sudden movement and accidental injury, while another clean child's skin with alcohol at site of antecubital vein, pricked the antecubital fossa with stainless steel needle and filled the trace element-free blood collection tube in a continuous process. Guangzhou KingMed Diagnostics Group Co., Ltd., the leading independent clinical laboratory in China, was responsible for the analysis of serum zinc. All blood samples were stored at 4°C in a portable cool box and sent to KingMed Lanzhou lab for a 10-minute centrifugation to separate serum. Then the serum samples were transported with low-temperature-assured containers to KingMed Shanghai lab, where Agilient 7700 ICP-MS was used to analyze zinc level. Serum zinc level was reported in mg/L.

## Annex E Baseline data collection: child anthropometric measures

1. Trained enumerators weighed children using an electronic scale which can measure up to 150 kg and with a precision of 0.1 kg. Communication with the child was organized in a sensitive, non-frightening way. Before weighing, the child needed to remove outer clothing to obtain an accurate weight. The child was guided by the enumerator to step on the scale along and remain still until the weight appeared on the display. The enumerator recorded the child's weight to the nearest 0.1 kg after measuring twice. If the weather was too cold to undress the child, or if the child resisted being undressed and became agitated, the enumerator would instead weight the clothed child and take the record of the estimated weight of his/her cloth. However, this situation was rare in the field.
2. Trained enumerators measured the standing height of the child. A measuring tape was fixed firmly on the wall, perpendicular to the level ground. Before measuring the height, the enumerator would make sure that the child's shoes, socks, and hair ornaments have been removed, then helped the child stand on the ground with feet slightly apart, back of the head, shoulder blades, buttocks, and heals all touching the vertical wall, legs straight, and feet flat. Keeping that position, the enumerator pulled down a ruler to rest firmly on top of the child's head and compress the hair. The last step was to read the measurement and record the child's height in centimeters to the last completed 0.1 cm.
3. Values of relevant child anthropometric indicators are determined against the WHO Child Growth Standards, WHO Growth reference data for 5-19 years[51]:
    - **Stunting**: Stunted growth refers to low height-for-age with long-term development risks, when a child is short for his/her age but not necessarily thin. It is the most common measurement to identify chronic malnutrition. A child is defined as stunted if 1) his/her height for age is more than two standard deviation below the WHO Child Growth Standards median for children under 5 years (<61 months); and 2) his/her height for age is more than two standard deviation below the WHO Growth reference data for 5-19 years (≥61 months).
    - **Wasting**: Wasting refers to low weight-for-height where a child is thin for his/her height but not necessarily short. Also known as acute malnutrition carrying an immediate increased risk of morbidity and mortality, it is defined as 1) a child's weight for height being more than two standard deviation below the WHO Child Growth Standards median for children under 5 years; and 2) a child's Body Mass Index (BMI) for age, calculated by dividing a child's weight in kilograms by the square of height in meters, being more than two standard deviation below the WHO Growth reference data for 5-19 years.
    - **Underweight**: Underweight refers to low weight-for-age, when a child can be either thin or short for his/her age. This reflects a combination of chronic and acute malnutrition. A child is defined as underweight if 1) his/her weight for age is more than two standard deviation below the WHO Child Growth Standards

[51] WHO Global Database on Child Growth and Malnutrition. Retrieved at: https://www.who.int/nutgrowthdb/about/introduction/en/index2.html

median for children under 5 years; and 2) his/her weight for age is more than two standard deviation below the WHO Growth reference data for 5-19 years.

- **Overweight** and **obesity**: Both weight-for height and age- and gender-specific BMI are measures used to determine childhood overweight and obesity. Overweight is defined as 1) a child's weight-for height being between two and three standard deviations above the WHO Child Growth Standards median; and 2) a child's BMI for age being between one and two standard deviations above the WHO Growth reference data for 5-19 years. Obesity is defined as 1) a child's weight-for height being over two standard deviations above the WHO Child Growth Standards median; and 2) a child's BMI for age being over three standard deviations above the WHO Growth reference data for 5-19 years.

## Annex F Baseline data collection: child cognition and academic performance

1. The Chinese version of the fourth edition of the Wechsler Preschool and Primary Scale of Intelligence (WPPSI-IV) & the Wechsler Intelligence Scale for Children (WISC-IV) were used to measure the child's ability across different areas of cognitive functioning and produced scaled scores to show his/her age-based performance. The test contents and scale were broken out into three age bands: younger group from 2 and a half years old to 3 years, 11 months and middle-age group from 4 years old to 6 years, 11 months were measured with different age-applied versions of WPPSI-IV. The older group from 7 years old to 15 years, 11 months was measured by WISC-IV. Before the test, the child was told that she/he would be invited to take part in some interesting activities, and she/he would need to listen carefully and follow the directions of the examiners, who were trained to help the child relax and approach the activities positively. All the test items were designed to be appealing and engaging to children.
2. The test contents and scale were broken out into three age bands:
    - WPPSI-IV: different age-applied version of WPPSI-IV were applied to younger group from 2 and a half years old to 3 years, 11 months, as well as middle-age group from 4 years old to 6 years, 11 months.
    - WISC-IV: older group from 7 years old to 15 years, 11 months.
3. Two index scores were calculated for each sample child. The Verbal Comprehension Index (VCI) measured the child's comprehension and reasoning using his/her verbal skills, as well as the child's knowledge already gained, and how well he/she responds to verbal cues.
    - Subtests in WPPSI-IV regarding VCI: children under 4 years old were asked to take the Receptive Vocabulary and Information subtests, while 4-6 years old children took Information and Similarities subtests.
    - Subtests in WISC-IV regarding VCI: children above 7 years old were asked to take Similarities and Vocabulary subtests. The Information subtest measured general cultural knowledge, long-term memory, and acquired facts. The Similarities subtest measured logical thinking, verbal concept formation, and verbal abstract reasoning. The Vocabulary subtest measured verbal fluency and concept formation, word knowledge and word usage. Three similar but different concepts/objects were presented, and the child was asked to tell how they are alike or different. Receptive Vocabulary assessed the child's ability to identify correct responses to spoken words. The child should indicate the depicted object by pointing to it.
4. The Working Memory Index (WMI) measured the child's ability to memorize new information, hold it in short-term memory, concentrate, manipulate that information to produce some result or reasoning processes, and resist interference from previously memorized items.

- Subtests in WPPSI-IV regarding WMI: children under 7 years old were asked to take Picture Memory and Zoo Location subtests. The Picture Memory subtest required the child to memorize one or more pictures for a specified time and identify them from options on a response page. When going through the Zoo Locations subtest, the child needed to memorize the location of animal cards on a zoo layout for a specified time and then placed the cards in the previously viewed location.
- Subtests in WISC-IV regarding WMI: children above 7 years old were asked to take Digit Span and Letter-Number Sequencing subtests. The Digit Span subtest measured short-term memory and compile ability. It required children to repeat the digit forwardly or reversely to spoken numbers. To complete the Letter-Number Sequencing, the child must repeat numbers then letters each in proper older when they were presented a series of numbers and letters.

5. Numerical index scores 70-130+ indicated 7 performance levels from extremely low to very superior, with scores from 90 to 109 considered average. If the child scored in the average range or above in the test, he/she would likely be able to express him/herself in verbal terms, digest verbal information productively, and show certain ability to sustain attention, concentrate, and exert mental control.
6. On the other hand, lower scores suggested the child's verbal comprehension or/and working memory skills was in a weak area for continued intervention. A score of 80-89 was defined as Low Average but child in this range was still able to perform as expected. Children who tested in the 70-79 (Borderline) range performed worse than approximately 91% of children the same age in the WPPSI-IV and WISC-IV normative sample and might have some learning disabilities. Children who tested in below 70 (Extremely Low) range performed worse than about 98% of children the same age and might need to be placed in special courses.
7. In the baseline survey, match test designed by primary education expert was conducted to measure the academic performance of all the students in grade 4-6. The math paper contains 31, 30 and 28 multiple-choice questions for $4^{th}$ grade, $5^{th}$ grade and $6^{th}$ grade sample students respectively, testing their knowledge of geography, geometry and arithmetic.
8. Two enumerators were sent to each classroom to keep order in the classroom and prevent students from cheating. Students participating in the test had 25 minutes to answer the questions after enumerators handed out the paper. All questions contain four options but only one is correct.
9. The study set 1 point for each question. The full score was 31, 30, and 28 for $4^{th}$, $5^{th}$, and $6^{th}$ grade. Students were classified as "passed" if they got 60% points. Accordingly, 18.60, 18 and 16.80 were set as borderline scores for $4^{th}$ ,$5^{th}$ and $6^{th}$ grade. In addition, student got over 85% points would be marked as excellent.

## Annex G Findings from Cognition and Academic Performance Test

### 1. Child Cognitive Level

1.1 The Chinese version of the fourth edition of the Wechsler Preschool and Primary Scale of Intelligence (WPPSI-IV) & the Wechsler Intelligence Scale for Children (WISC-IV)[52] were used to measure the child's ability across different areas of cognitive functioning and produced scaled scores to show his/her age-based performance. Working Memory Index (WMI) and Verbal Comprehension Index (VCI) were calculated to reveal children's cognition status.

1.2 Baseline data (Table 43) showed that the **VCI and WMI scores of sample children averaged 77.33 (Borderline) and 81.55 (Low Average level)** respectively. Within 77.03% children who had a VCI lower than average level, **32.58% of them fell into the range of extremely low**. Comparing with the VCI, WMI score was a bit better. **62.29% children had WMI lower than average level, contains 14.35% at the level of extremely low.**

1.3 Children in the lower VCI ranges might face difficulties when handling language-type tasks, at risk for listening comprehension, verbal reasoning, and oral responding. Lower WMI score showed that the child had problem in concentrating and attending to information that is presented to him/her. For this type of child, processing of complex information might be more time consuming compared to counterparts, potentially resulting in difficulties in a variety of learning tasks. Cognitive difficulties were relatively common among sample children, putting them at risk of educational failure.

1.4 In 2018, the team conducted the baseline survey for the WFP-led preschool feeding program in Xiangxi, Hunan Province. Sample children aged 3-5 in the Xiangxi survey scored higher than the Gansu sample. Their average WMI and VCI score was 90.43 and 86.02, respectively.21.04% children had WMI lower than average level. 30.48% children had VCI lower than average level.

1.5 In terms of disaggregated data, significant differences were detected among different age groups. Both the **WMI and VCI of 4-6 years old children were significantly higher** than the scores of children aged 3 and aged 7 and older. Children from families **at the status of poverty scored significantly lower** than their counterparts from non-poor families. The average VCI of children from poor family was 74.20 and the other group scored 86.19. The average WMI of children from poor family was 79.21, while the other group scored 89.37.

1.6 Similarly, an obvious difference existed when considering the counties and ethnicity. **The children from Dongxiang scored much lower than children from Anding, and children who is non-Han scored lower than the one who was Han.** However, no significant differences existed when considering the registered poverty status. The same was true when comparing the performance across other groups, including, treatment status, gender, parental marriage changes, and left-behind status.

[52]Detailed test methods and relevant definition could be found in Annex F.

Table 43. Disaggregated data for child cognitive level

| | Average VCI | Low VCI (%) | Extremely Low VCI (%) | Average WMI | Low WMI (%) | Extremely Low WMI (%) |
|---|---|---|---|---|---|---|
| **overall** | 77.33 | 77.03% | 32.58% | 81.55 | 62.29% | 14.35% |
| **Age** | | | | | | |
| 3 years old | 72.90 | 83.82% | 45.58% | 83.34 | 66.18% | 8.82% |
| 4-6 years old | 80.94 | 74.80% | 21.58% | 89.65 | 52.89% | 2.11% |
| 7-years and older | 74.30 | 77.90% | 41.93% | 77.30 | 76.20% | 29.52% |
| **County** | | | | | | |
| Anding | 86.28 | 61.52% | 11.52% | 89.35 | 50.28% | 4.78% |
| Dongxiang | 70.18 | 93.93% | 53.93% | 79.22 | 78.72% | 26.24% |
| **Treatment Status** | | | | | | |
| Treated | 74.088 | 82.80% | 48.00% | 79.20 | 74.46% | 32.03% |
| Comparison | 77.47 | 79.55% | 34.09% | 82.72 | 68.81% | 18.81% |
| **Gender** | | | | | | |
| Female | 77.51 | 79.50% | 35.00% | 83.46 | 67.09 | 16.84% |
| Male | 77.69 | 79.11% | 33.70% | 84.34 | 64.64% | 15.36% |
| **Ethnicity** | | | | | | |
| Han | 86.19 | 61.54% | 11.84% | 89.37 | 50.89% | 5.03% |
| Non-Han | 70.69 | 93.59% | 52.49% | 79.21 | 78.70% | 25.56% |
| **Household Poverty Status** | | | | | | |
| Non-Poor | 83.04 | 62.5% | 26.39% | 87.74 | 54.29% | 10.00% |
| Poor | 74.20 | 84.07% | 44.23% | 81.69 | 72.13% | 20.69% |
| **Left-Behind Status** | | | | | | |
| Non-Left-Behind | 77.03 | 80.77% | 35.61% | 83.46 | 66.62% | 17.38% |
| Left-Behind | 80.312 | 74.35 | 24.78 | 86.21 | 61.16% | 12.05% |

## 2. Child Academic Performance[53]

**2.1** A standardized math test was conducted among all the sample students in grade 4-6. Baseline data (Table 44) showed **that the average score of all sample students was 12.40. 22.59% of sample students passed the test with only 1.93% reaching the excellent level.**

**2.2** The average scores of students in grade 4-6 were 11.78, 13.56, and 11.60 respectively. **The highest passing rate was 27.41% in 5th grade, and the lowest one was 18.12% in 4th grade.**

2.3 In terms of disaggregated data, significant differences were detected between groups defined by grade, gender, and household poverty status. Scores of students from grade 5 was significantly higher than those in other two grades. Similar to the results of cognitive tests, the males got better scores than females and the children from poverty families got lower score than their counterparts. **Children from Dongxiang got lower average scores (7.59) than their counterparts from Anding**. The passing rate also showed the obvious difference (43.89%).

[53]Detailed test methods and relevant definition could be found in Annex F.

Table 44. Disaggregated data for child academic performance

| | Average | Above Average (%) | Passing Rate (%) | Excellent Rate (%) |
|---|---|---|---|---|
| **Overall** | 12.40 | 44.90% | 22.59% | 1.93% |
| **Grade** | | | | |
| Grade 4 | 11.78 | 47.10% | 18.12% | 1.45% |
| Grade 5 | 13.56 | 46.67% | 27.41% | 2.96% |
| Grade 6 | 11.60 | 41.11% | 22.22% | 2.22% |
| **Country** | | | | |
| Dongxiang | 9.16 | 41.76% | 3.85% | 0.55% |
| Anding | 16.75 | 53.55% | 47.74% | 3.87% |
| **Gender** | | | | |
| Female | 11.96 | 48.13% | 18.75% | 1.88% |
| Male | 13.34 | 46.86% | 29.14% | 2.29% |
| **Ethnicity** | | | | |
| Non-Han | 9.16 | 41.76% | 3.85% | 0.55% |
| Han | 16.75 | 53.55% | 47.74% | 3.87% |
| **Household Poverty Status** | | | | |
| Non-Poor | 13.78 | 50.90% | 33.53% | 2.99% |
| Poor | 11.54 | 46.47% | 14.71% | 1.18% |
| **Left-Behind Status** | | | | |
| Non-Left-Behind | 12.41 | 45.54% | 22.78% | 1.65% |
| Left-Behind | 14.29 | 44.05% | 30.95% | 2.38% |

## Annex H Disaggregated zinc status by counties and townships

Table 45. Zinc deficiency status among sample children, by counties

| | Dongxiang County | | | Anding District | | | Overall |
|---|---|---|---|---|---|---|---|
| | **Dashu** | **Beiling** | **Subtotal** | **Lujiagou** | **Gejiacha** | **subtotal** | |
| Hair zinc deficiency | 22.83% | 21.35% | 22.14% | 17.75% | 17.52% | 17.65% | 20.22% |
| Zinc intake lower than EAR | 23.73% | 18.55% | 21.78% | 26.36% | 17.41% | 20.93% | 21.30% |
| Zinc intake lower than RNI | 23.73% | 18.82% | 22.54% | 26.74% | 18.52% | 21.08% | 21.71% |

Table 46. Disaggregated zinc deficiency status among sample children, by townships in Dongxiang County

| | Dashu Township | | | Beiling Township | | |
|---|---|---|---|---|---|---|
| | Hair zinc deficiency | Zinc intake lower than EAR | Zinc intake lower than RNI | Hair zinc deficiency | Zinc intake lower than EAR | Zinc intake lower than RNI |
| Overall | 22.83% | 23.73% | 23.73% | 21.35% | 18.55% | 18.82% |
| **Gender** | | | | | | |
| Female | 24.56% | 24.68% | 24.68% | 24.51% | 16.22% | 16.22% |
| Male | 20.95% | 22.84% | 22.84% | 17.78% | 20.86% | 21.39% |
| **Education** | | | | | | |
| Preschool | 53.33% | 26.39% | 26.39% | 39.62% | 23.16% | 24.21% |
| Primary School | 17.99% | 18.00% | 18.00% | 14.39% | 16.97% | 16.97% |
| **Ethnicity** | | | | | | |
| Han | - | - | - | - | - | - |
| Non-Han | 22.83% | 23.73% | 23.73% | 21.47% | 18.55% | 18.82% |
| **Household Poverty Status** | | | | | | |
| Non-Poor | 30.68% | 18.57% | 28.57% | 15.00% | 20.00% | 20.33% |
| Poor | 17.56% | 15.04% | 15.04% | 24.24% | 12.50% | 12.50% |
| **Left-Behind Status** | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Non-Left-Behind | 21.47% | 12% | 20.45% | 20.00% | 16.17% | 14.87% |
| Left-Behind | 28.57% | 34.63% | 26.67% | 25.53% | 23.91% | 26.67% |

Table 47. Disaggregated zinc deficiency status among sample children, by townships in Anding District

| | Lujiagou Township | | | Gejiacha Township | | |
|---|---|---|---|---|---|---|
| | Hair zinc deficiency | Zinc intake lower than EAR | Zinc intake lower than RNI | Hair zinc deficiency | Zinc intake lower than EAR | Zinc intake lower than RNI |
| Overall | 17.75% | 26.36% | 26.74% | 17.52% | 17.41% | 18.52% |
| **Gender** | | | | | | |
| Female | 20.54% | 29.93% | 29.93% | 19.19% | 19.57% | 20.29% |
| Male | 12.28% | 22.31% | 23.14% | 13.16% | 15.15% | 16.67% |
| **Education** | | | | | | |
| Preschool | 33.33% | 31.46% | 32.58% | 29.73% | 21.15% | 21.15% |
| Primary School | 12.60% | 23.67% | 23.67% | 13.00% | 15.06% | 16.87% |
| **Ethnicity** | | | | | | |
| Han | 17.68% | 26.88% | 27.27% | 17.52% | 17.41% | 18.52% |
| Non-Han | 20.00% | 25.34% | 25.89% | - | - | - |
| **Household Poverty Status** | | | | | | |
| Non-Poor | 19.05% | 26.34% | 26.79% | 17.17% | 11.11% | 11.11% |
| Poor | 15.63% | 26.47% | 26.47% | 18.42% | 18.11% | 19.34% |
| **Left-Behind Status** | | | | | | |
| Non-Left-Behind | 21.25% | 24.87% | 23.62% | 17.39% | 12.28% | 12.28% |
| Left-Behind | 14.61% | 27.78% | 29.63% | 17.65% | 22.49% | 25.63% |

Table 48. Iron deficiency status among sample children, by counties

| | Dongxiang County | | | Anding District | | | Overall |
|---|---|---|---|---|---|---|---|
| | **Dashu** | **Beiling** | **subtotal** | **Lujiagou** | **Gejiacha** | **subtotal** | |
| Iron intake lower than EAR | 22.47% | 17.47% | 21.78% | 25.19% | 14.81% | 20.93% | 21.30% |
| Iron intake lower than RNI | 22.47% | 18.01% | 22.54% | 26.74% | 15.56% | 21.08% | 21.71% |

## Annex I Disaggregated anthropometric status by counties and townships

Table 49. Anthropometric status among sample children, by counties

| | | Dongxiang County | | | Anding District | | | Overall |
|---|---|---|---|---|---|---|---|---|
| | | Dashu | Beiling | Subtotal | Lujiagou | Gejiacha | Subtotal | |
| Undernutrition | Stunning | 24.18% | 12.50% | 18.60% | 7.41% | 10.19% | 8.50% | 14.50% |
| | Underweight | 14.14% | 13.43% | 13.76% | 7.22% | 14.56% | 9.76% | 12.07% |
| | Wasting | 8.82% | 9.29% | 9.04% | 6.17% | 9.62% | 7.52% | 8.43% |
| Overnutrition | Overweight | 1.63% | 3.21% | 2.39% | 9.88% | 8.33% | 9.27% | 5.18% |
| | Obesity | 0.98% | 1.43% | 1.19% | 4.53% | 1.92% | 3.51% | 2.13% |

Table 50. Disaggregated data of child anthropometric status in Dashu township

| | Undernutrition | | | Overnutrition | |
|---|---|---|---|---|---|
| | Stunting | Underweight | Wasting | Overweight | Obesity |
| **Overall** | 24.18% | 14.14% | 8.82% | 1.63% | 0.98% |
| **Gender** | | | | | |
| Female | 24.67% | 13.40% | 8.00% | 0.67% | 0.67% |
| Male | 23.72% | 14.89% | 9.62% | 2.56% | 1.28% |
| **Education** | | | | | |
| Preschool | 8.16% | 10.20% | 2.04% | 0 | 0 |
| Primary School | 27.24% | 15.49% | 10.12% | 1.95% | 1.17% |
| **Ethnicity** | | | | | |
| Han | - | - | - | - | - |
| Non-Han | 24.18% | 14.14% | 8.82% | 1.63% | 0.98% |
| **Household Poverty Status** | | | | | |
| Non-Poor | 24.59% | 8.00% | 8.20% | 0.82% | 0.82% |
| Poor | 23.91% | 18.10% | 9.24% | 2.17% | 1.09% |
| **Left-Behind Status** | | | | | |
| Non-Left-Behind | 25.62% | 17.57% | 8.26% | 1.65% | 0.83% |
| Left-Behind | 18.75% | 2.33% | 10.94% | 1.56% | 1.56% |

Table 51. Disaggregated data of child anthropometric status in Beiling Township

| | Undernutrition | | | Overnutrition | |
|---|---|---|---|---|---|
| | Stunting | Underweight | Wasting | Overweight | Obesity |
| **Overall** | 12.50% | 13.43% | 9.29% | 3.21% | 1.43% |
| **Gender** | | | | | |
| Female | 13.97% | 15.15% | 11.03% | 3.68% | 0.74% |
| Male | 11.11% | 11.97% | 7.64% | 2.78% | 2.08% |
| **Education** | | | | | |
| Preschool | 11.39% | 11.25% | 10.13% | 5.06% | 0 |
| Primary School | 12.94% | 14.71% | 8.96% | 2.49% | 1.99% |
| **Ethnicity** | | | | | |
| Han | 100% | 0 | 0 | 0 | 0 |
| Non-Han | 12.19% | 13.43% | 9.32% | 3.23% | 1.43% |
| **Household Poverty Status** | | | | | |
| Non-Poor | 15.79% | 14.86% | 10.53% | 2.11% | 2.11% |
| Poor | 10.81% | 12.68% | 8.65% | 3.78% | 1.08% |
| **Left-Behind Status** | | | | | |
| Non-Left-Behind | 14.15% | 14.91% | 9.91% | 3.30% | 1.42% |
| Left-Behind | 7.35% | 9.09% | 7.35% | 2.94% | 1.47% |

Table 52. Disaggregated data of child anthropometric status in Lujiagou Township

| | Undernutrition | | | Overnutrition | |
|---|---|---|---|---|---|
| | Stunting | Underweight | Wasting | Overweight | Obesity |
| **Overall** | 7.41% | 7.22% | 6.17% | 9.88% | 4.53% |
| **Gender** | | | | | |
| Female | 6.82% | 8.41% | 5.30% | 11.36% | 3.03% |
| Male | 8.11% | 5.75% | 7.21% | 8.11% | 6.31% |
| **Education** | | | | | |
| Preschool | 6.25% | 3.75% | 7.50% | 3.75% | 1.25% |
| Primary School | 7.98% | 9.65% | 5.52% | 12.88% | 6.13% |
| **Ethnicity** | | | | | |
| Han | 7.56% | 7.41% | 6.30% | 10.08% | 4.62% |
| Non-Han | 0 | 0 | 0 | 0 | 0 |
| **Household Poverty Status** | | | | | |
| Non-Poor | 6.29% | 9.38% | 6.92% | 8.18% | 6.29% |
| Poor | 9.52% | 3.03% | 4.76% | 13.10% | 1.19% |
| **Left-Behind Status** | | | | | |
| Non-Left-Behind | 9.70% | 8.82% | 5.97% | 8.96% | 3.73% |
| Left-Behind | 4.59% | 5.43% | 6.42% | 11.01% | 5.50% |

Table 53. Disaggregated data of child anthropometric status in Gejiacha Township

| | Undernutrition | | | Overnutrition | |
|---|---|---|---|---|---|
| | Stunting | Underweight | Wasting | Overweight | Obesity |
| **Overall** | 10.19% | 14.56% | 9.62% | 8.33% | 1.92% |
| **Gender** | | | | | |
| Female | 10.26% | 21.43% | 12.99% | 3.90% | 1.30% |
| Male | 10.13% | 6.38% | 6.33% | 12.66% | 2.53% |
| **Education** | | | | | |
| Preschool | 33.33% | 11.11% | 11.11% | 11.11% | 0 |
| Primary School | 8.78% | 14.89% | 9.52% | 8.16% | 2.04% |
| **Ethnicity** | | | | | |
| Han | 10.26% | 14.71% | 9.68% | 8.39% | 1.94% |
| Non-Han | 0 | 0 | 0 | 0 | 0 |
| **Household Poverty Status** | | | | | |
| Non-Poor | 10.10% | 11.43% | 11.11% | 11.11% | 2.02% |
| Poor | 10.34% | 21.21% | 7.02% | 3.51% | 1.75% |
| **Left-Behind Status** | | | | | |
| Non-Left-Behind | 7.23% | 16.36% | 7.32% | 7.32% | 1.22% |
| Left-Behind | 13.51% | 12.50% | 12.16% | 9.46% | 2.70% |

## Annex J Disaggregated agricultural data by counties and townships

Table 54. Characteristics of the sample farmers by township

| | Dongxinag | | | Anding | | | Total |
|---|---|---|---|---|---|---|---|
| | Dashu | Beiling | Subtotal | Lujiagou | Gejiacha | subtotal | |
| **Characteristics of the farmer:** | | | | | | | |
| Age (years) | 42.76 | 40.78 | 41.78 | 46.78 | 46.95 | 46.87 | 44.28 |
| Female (%) | 50.08 | 51.22 | 50.64 | 50.37 | 50.00 | 50.18 | 50.41 |
| Education (years) | 1.63 | 2.09 | 1.85 | 5.98 | 5.08 | 5.51 | 3.65 |
| **Characteristics of the farmer households:** | | | | | | | |
| Family size | 5.36 | 4.88 | 5.11 | 4.38 | 4.36 | 4.37 | 4.72 |
| Number of children | 2.25 | 1.95 | 2.10 | 1.12 | 1.32 | 1.22 | 1.71 |
| Average age of children under 18 years old | 8.35 | 7.72 | 8.03 | 7.64 | 8.26 | 7.95 | 8.00 |
| **Other characteristics (% of all sample farmers):** | | | | | | | |
| Han | 5.01 | 0.00 | 2.56 | 99.44 | 1.00 | 99.73 | 49.04 |
| Dongxiang ethnic minority | 96.49 | 99.82 | 98.12 | 0.00 | 0.00 | 0.00 | 50.00 |
| Other minorities | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Are you a village cadre? | 1.36 | 1.75 | 1.55 | 1.33 | 1.18 | 1.25 | 1.40 |
| Are you healthy? | 82.00 | 82.31 | 82.16 | 83.46 | 70.61 | 76.65 | 79.46 |
| Have you ever received nutrition training? | 1.87 | 0.35 | 1.12 | 1.53 | 1.19 | 1.35 | 1.23 |
| **Number of family members engaged in the following employment:** | | | | | | | |
| Farm work | 3.94 | 3.89 | 3.91 | 2.58 | 3.14 | 2.86 | 3.36 |
| Off-farm work | 2.09 | 2.10 | 2.09 | 2.66 | 2.71 | 2.69 | 2.43 |
| Unemployed | 3.04 | 2.85 | 2.95 | 2.97 | 2.79 | 2.88 | 2.91 |
| **Does the farmer belong to (% of all sample farmers):** | | | | | | | |
| Farmer's cooperative | 3.80 | 3.68 | 3.74 | 4.93 | 7.73 | 6.34 | 5.10 |
| Villagers' self-help organization | 0.00 | 0.00 | 0.00 | 1.97 | 2.42 | 2.20 | 1.15 |
| **Has the household received any support from any targeted poverty alleviation programs (% of all sample farming households)** | | | | | | | |
| Subsistence allowance | 15.76 | 33.68 | 24.87 | 13.30 | 10.14 | 11.71 | 17.98 |
| Exceptional poverty allowance | 12.50 | 20.00 | 16.31 | 9.85 | 10.63 | 10.24 | 13.14 |
| Allowance for official registered poor households | 48.91 | 41.05 | 44.92 | 26.11 | 22.22 | 24.15 | 34.06 |

Table 55. Farming households' income by township (yuan)

| | Dongxiang | | | Anding | | | Total |
|---|---|---|---|---|---|---|---|
| | Dashu | Beiling | Subtotal | Lujiagou | Gejiacha | Subtotal | |
| Total | 41266.34 | 31674.89 | 35904.02 | 43345.22 | 39338.19 | 41398.62 | 39593.63 |
| Income Breakdown (%) | | | | | | | |
| Crop income | 5.69 | 0.72 | 1.17 | 2.09 | 2.05 | 2.13 | 1.64 |
| Potato | 0.12 | 0.09 | 0.11 | 0.67 | 1.61 | 1.20 | 0.71 |
| Corn | 1.31 | 0.63 | 1.04 | 0.86 | 0.16 | 0.52 | 0.70 |
| Other | 4.26 | 0.00 | 0.02 | 0.56 | 0.28 | 0.40 | 0.23 |
| Livestock income | 4.67 | 5.23 | 5.03 | 7.16 | 6.16 | 6.62 | 6.07 |
| Business income | 1.13 | 3.83 | 2.36 | 9.61 | 5.46 | 7.65 | 5.81 |
| Off-farm income | 34.72 | 54.66 | 44.43 | 68.02 | 64.41 | 66.33 | 58.77 |
| Transfer income | 53.79 | 35.56 | 47.02 | 13.13 | 21.91 | 17.27 | 27.70 |

Table 56. Cropping structure of farming household by township (mu)

| | Dongxiang | | | Anding | | | Total |
|---|---|---|---|---|---|---|---|
| | Dashu | Beiling | Subtotal | Lujiagou | Gejiacha | Subtotal | |
| Total sown area | 5.67 | 4.50 | 5.1 | 12.58 | 14.49 | 13.65 | 8.85 |
| Potato | 1.59 | 1.58 | 1.65 | 3.55 | 3.88 | 3.75 | 2.55 |
| Corn | 2.68 | 1.88 | 2.25 | 3.69 | 3.20 | 3.45 | 2.85 |
| Alfalfa | 0.43 | 0.45 | 0.45 | 0.24 | 0.29 | 0.3 | 0.3 |
| Wheat | 0.38 | 0.45 | 0.45 | 0.09 | 1.47 | 0.75 | 0.6 |
| Flax | 0.00 | 0.00 | 0 | 0.50 | 1.39 | 0.9 | 0.45 |
| Oat | 0.00 | 0.00 | 0 | 0.12 | 0.26 | 0.15 | 0.15 |
| Hyacinth bean | 0.00 | 0.00 | 0 | 0.15 | 0.86 | 0.45 | 0.3 |
| Other crops | 0.40 | 0.01 | 0.3 | 0.97 | 1.04 | 3.9 | 1.65 |

Table 57. Livestock of farming households by township (heads)

| | Dongxiang | | | Anding | | | Total |
|---|---|---|---|---|---|---|---|
| | Dashu | Beiling | Subtotal | Lujiagou | Gejiacha | Subtotal | |
| Sheep | 15.12 | 34.60 | 24.66 | 22.07 | 13.67 | 17.64 | 22.32 |
| Beef Cattle | 16.41 | 10.67 | 14.60 | 23.67 | 12.14 | 15.60 | 15.07 |
| Pork Pig | 0.00 | 0.00 | 0.00 | 88.54 | 11.83 | 46.39 | 46.39 |
| Piglet | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 13.43 | 13.43 |
| Chicken | 26.95 | 13.63 | 23.14 | 105.68 | 27.08 | 67.83 | 61.25 |
| Duck | 0.00 | 0.00 | 0.00 | 0.00 | 29.00 | 29.00 | 29.00 |
| Donkey | 11.15 | 10.69 | 10.92 | 28.28 | 9.74 | 14.19 | 12.17 |
| Mule | 30.00 | 14.67 | 18.50 | 2.00 | 8.86 | 8.00 | 11.50 |

Table 58. Household potato usage by township

| | Dongxiang | | | Anding | | | Total |
|---|---|---|---|---|---|---|---|
| | Dashu | Beiling | Subtotal | Lujiagou | Gejiacha | Subtotal | |
| Usage of the potato (%) | | | | | | | |
| Self-consumption | 79.51 | 83.45 | 81.47 | 55.31 | 33.74 | 42.67 | 64.26 |
| Seed | 4.75 | 3.55 | 4.15 | 19.08 | 15.49 | 16.97 | 9.84 |
| Sold | 3.42 | 2.04 | 2.74 | 16.42 | 42.37 | 31.62 | 15.55 |
| Loss | 11.53 | 9.33 | 10.44 | 5.29 | 6.68 | 6.10 | 8.52 |
| Others (exchange, gift etc) | 0.76 | 1.59 | 1.17 | 2.98 | 1.70 | 2.23 | 1.64 |
| Annual production (ton) | 0.96 | 0.77 | 0.86 | 1.03 | 1.70 | 1.37 | 1.13 |

Table 59. Potato storage of potato farming household by township

| | Dongxiang | | | Anding | | | Total |
|---|---|---|---|---|---|---|---|
| | Dashu | Beiling | Subtotal | Lujiagou | Gejiacha | Subtotal | |
| Do you have a storage facility? (%) | 85.88 | 95.32 | 91.48 | 93.69 | 89.94 | 90.62 | 91.00 |
| Types of the potato storage (%) | | | | | | | |
| Constant temperature storage | 0.68 | 1.84 | 1.29 | 2.88 | 0.70 | 1.62 | 1.44 |
| Over ground | 1.37 | 1.84 | 1.62 | 2.88 | 4.20 | 3.64 | 2.52 |
| Natural ventilation cellar | 4.11 | 5.52 | 4.85 | 3.85 | 3.50 | 3.64 | 4.32 |
| Traditional cellar | 93.84 | 90.80 | 92.23 | 90.38 | 91.61 | 91.09 | 91.73 |
| Storage capacity (ton) | 1.96 | 1.74 | 1.85 | 6.80 | 2.13 | 4.08 | 2.84 |

Table 60. Seed potato varieties by township (% of total potato farming households)

| | Dongxiang | | | Anding | | | Total |
|---|---|---|---|---|---|---|---|
| | Dashu | Beiling | Subtotal | Lujiagou | Gejiacha | Subtotal | |
| Xindaping | 3.79 | 0 | 2.09 | 82.88 | 52.83 | 65.19 | 35.56 |
| Longshu NO.3 | 33.71 | 48.13 | 40.17 | 2.70 | 9.43 | 6.67 | 22.40 |
| Zhuangshu NO.3 | 14.02 | 24.77 | 18.82 | 2.25 | 0.63 | 1.30 | 9.53 |
| Qingshu NO.9 | 9.85 | 13.08 | 11.29 | 1.80 | 11.64 | 7.59 | 9.33 |
| Longshu NO.10 | 1.89 | 0 | 1.04 | 5.41 | 18.24 | 12.96 | 7.37 |
| Longshu NO.7 | 17.42 | 0 | 9.62 | 1.80 | 1.89 | 1.85 | 5.50 |
| Longshu NO.8 | 0 | 0 | 0 | 1.35 | 1.26 | 1.30 | 0.69 |
| Ailan NO.1 | 2.27 | 0 | 1.25 | 0 | 0 | 0 | 0.59 |
| Heimeiren | 0.76 | 0.93 | 0.83 | 0.90 | 0 | 0.37 | 0.59 |
| Qingshu NO.168 | 0.38 | 0 | 0.20 | 0 | 0.63 | 0.37 | 0.29 |
| Ganyin NO.2 | 0.76 | 0 | 0.41 | 0 | 0 | 0 | 0.20 |
| Longshu NO.6 | 0 | 0 | 0 | 0 | 0.63 | 0.37 | 0.20 |
| Ganyin NO.1 | 0 | 0 | 0 | 0.45 | 0 | 0.19 | 0.10 |
| Others | 15.15 | 13.08 | 14.22 | 0.45 | 2.83 | 2.22 | 7.66 |

Table 61. Factors of farmers choose potato seed variety (% of total sample farmers)

| | Dongxiang | | | Anding | | | Total |
|---|---|---|---|---|---|---|---|
| | Dashu | Beiling | Subtotal | Lujiagou | Gejiacha | Subtotal | |
| Taste | 22.83 | 28.04 | 25.47 | 59.11 | 39.61 | 49.27 | 37.93 |
| Yield | 32.07 | 51.85 | 42.09 | 23.15 | 39.61 | 31.46 | 36.53 |
| Government distribution for free | 35.33 | 12.17 | 23.59 | 1.48 | 3.86 | 2.68 | 12.64 |
| Drought resistance | 0.54 | 1.06 | 0.8 | 6.4 | 5.8 | 6.1 | 3.58 |
| Pest tolerance | 1.09 | 0.53 | 0.8 | 0.49 | 1.45 | 0.98 | 0.89 |
| Seed price | 2.17 | 1.59 | 1.88 | 0.99 | 2.9 | 1.95 | 1.92 |
| Good sales | 1.63 | 3.17 | 2.41 | 4.93 | 4.83 | 4.88 | 3.70 |
| Others | 2.72 | 0.53 | 1.61 | 2.46 | 1.93 | 2.2 | 1.92 |
| Have no idea | 1.63 | 1.06 | 1.34 | 0.99 | 0.00 | 0.49 | 0.89 |

Table 62. Channels to receive zinc-enriched potato information (%)

| | Dongxiang | | | Anding | | | Total |
|---|---|---|---|---|---|---|---|
| | Dashu | Beiling | Subtotal | Lujiagou | Gejiacha | Subtotal | |
| | N=2 | N=9 | N=11 | N=9 | N=15 | N=24 | N=35 |
| Agricultural extensionist | 50 | 22.22 | 27.27 | 22.22 | 73.33 | 54.17 | 45.71 |
| Agricultural inputs seller | 0 | 0 | 0 | 0 | 6.67 | 4.17 | 2.9 |
| TV, broadcast | 0 | 11.11 | 9.09 | 0 | 0 | 0 | 2.9 |
| Product brochure | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fellow villagers or relatives | 50 | 55.56 | 54.55 | 33.33 | 6.67 | 16.67 | 28.57 |
| Others | 0 | 11.11 | 9.09 | 44.44 | 13.33 | 25 | 20 |

Table 63. Reasons for farmers to choose zinc-enriched potato variety (%)

| | Dongxiang | | | Anding | | | Total |
|---|---|---|---|---|---|---|---|
| | Dashu | Beiling | Subtotal | Lujiagou | Gejiacha | Subtotal | |
| | N=2 | N=8 | N=10 | N=7 | N=13 | N=20 | N=30 |
| Good taste | 50 | 50 | 50 | 57.14 | 38.46 | 42.86 | 46.67 |
| High yield | 50 | 37.5 | 40 | 14.29 | 23.08 | 19.05 | 26.67 |
| Government distribution for free | 0 | 0 | 0 | 0 | 7.69 | 4.76 | 3.33 |
| Drought resistance | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pest tolerance | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Low seed price | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Good sales | 0 | 0 | 0 | 0 | 7.69 | 4.76 | 3.33 |
| Good for health | 0 | 12.5 | 10 | 14.29 | 23.08 | 19.05 | 16.67 |
| Change a new variety | 0 | 0 | 0 | 14.29 | 0 | 9.52 | 3.33 |

Table 64. Preference for zinc-enriched potato training (%)

| | Dongxiang | | | Anding | | | Total |
|---|---|---|---|---|---|---|---|
| | Dashu | Beiling | Subtotal | Lujiagou | Gejiacha | Subtotal | |
| | N=1 | N=6 | N=7 | N=5 | N=10 | N=15 | N=22 |
| How to choose a variety | 100 | 66.67 | 71.43 | 0 | 30 | 18.75 | 36.36 |
| How to deal with seed potato | 0 | 0 | 0 | 40 | 0 | 12.5 | 9.09 |
| Land preparation and sowing techniques | 0 | 16.67 | 14.29 | 20 | 40 | 37.5 | 27.27 |
| Irrigation and fertile management | 0 | 0 | 0 | 20 | 0 | 6.25 | 4.55 |
| Pest control | 0 | 16.67 | 14.29 | 20 | 30 | 25 | 22.73 |

Table 65. Agricultural inputs

| | Dongxiang | | | Anding | | | Total |
|---|---|---|---|---|---|---|---|
| | Dashu | Beiling | Subtotal | Lujiagou | Gejiacha | Subtotal | |
| Potato seed (kg/mu) | 174.79 | 189.21 | 181.89 | 93.37 | 97.26 | 95.66 | 143.39 |
| Chemical fertilizer (kg/mu) | 121.10 | 79.54 | 100.32 | 47.84 | 52.28 | 50.45 | 78.18 |
| Manure (ton/mu) | 0.42 | 0.54 | 0.49 | 0.49 | 0.82 | 0.69 | 0.58 |
| Plastic mulch(roll/mu) | 0.25 | 0.05 | 0.15 | 0.40 | 0.30 | 0.34 | 0.23 |

Table 66. Potato seed sources in Dashu and Beiling Township

| | Dashu | | Beiling | | Total | |
|---|---|---|---|---|---|---|
| | 1st plot | 2nd plot | 1st plot | 2nd plot | 1st plot | 2nd plot |
| | N=169 | N=50 | N=160 | N=55 | N=329 | N=105 |
| Total Seed Usage (kg/mu) | 169.39 | 182.41 | 183.65 | 183.47 | 176.34 | 182.97 |
| A) self-reserved | 16.42 | 33.21 | 16.20 | 31.92 | 16.31 | 32.54 |
| B) exchange | 0 | 16.01 | 0.48 | 19.10 | 0.23 | 17.63 |
| C) purchased | 54.66 | 56.89 | 109.13 | 86.48 | 81.21 | 72.39 |
| D)government distribution for free | 98.31 | 76.28 | 57.83 | 45.95 | 78.57 | 60.39 |

Table 67. Potato seed sources in Lujiagou and Gejiacha Township

| | Lujiagou | | Gejiacha | | Total | |
|---|---|---|---|---|---|---|
| | 1st plot | 2nd plot | 1st plot | 2nd plot | 1st plot | 2nd plot |
| | N=109 | N=50 | N=157 | N=86 | N=266 | N=136 |
| Total Seed Usage (kg/mu) | 95.35 | 127.55 | 102.56 | 97.02 | 99.62 | 108.24 |
| A) self-reserved | 74.57 | 54.52 | 72.75 | 69.23 | 73.49 | 63.82 |
| B) exchange | 0.57 | 19.01 | 0 | 1.74 | 0.23 | 8.09 |
| C) purchased | 13.66 | 29.09 | 16.16 | 15.07 | 15.14 | 20.23 |
| D)government distribution for free | 6.53 | 24.91 | 13.64 | 10.96 | 10.74 | 16.09 |

Table 68. Labor structure of potato farming household of Dongxiang (workday/mu)

| | Dashu | | Beiling | | Total | |
|---|---|---|---|---|---|---|
| | 1st plot | 2nd plot | 1st plot | 2nd plot | 1st plot | 2nd plot |
| Family labor | 12.19 | 12.76 | 14.06 | 11.47 | 13.12 | 12.09 |
| Temporary workers | .11 | .32 | .30 | .12 | .20 | .21 |
| Exchange workers | .08 | .32 | .26 | .07 | .17 | .19 |
| Outsourced farming service | .03 | .03 | 0 | 0 | .01 | .01 |

Table 69. Labor structure of potato farming household of Anding (workday/mu)

| | Lujiagou | | Gejiacha | | Total | |
|---|---|---|---|---|---|---|
| | 1st plot | 2nd plot | 1st plot | 2nd plot | 1st plot | 2nd plot |
| Family labor | 15.09 | 9.74 | 9.08 | 8.79 | 11.50 | 9.01 |
| Temporary workers | .35 | .22 | .04 | .05 | .17 | .09 |
| Exchange workers | .11 | .02 | .20 | .44 | .17 | .34 |
| Outsourced farming service | .01 | 0 | .09 | 0 | .06 | 0 |

Table 70. Disasters suffered by potato farming household in 2018 (%)

| | Dongxiang | | | Anding | | | Total |
|---|---|---|---|---|---|---|---|
| | Dashu | Beiling | Subtotal | Lujiagou | Gejiacha | subtotal | |
| No disaster | 51.79 | 24.26 | 37.98 | 68.18 | 49.06 | 56.72 | 46.28 |
| Too much rain | 38.10 | 66.86 | 52.52 | 9.09 | 21.38 | 16.42 | 36.53 |
| Drought | 4.17 | 1.78 | 2.97 | 10.00 | 15.72 | 13.43 | 7.6 |
| Potato late blight epidemic | 0 | 0.59 | 0.3 | 1.82 | 1.26 | 1.49 | 0.83 |
| Diseases and pests | 3.57 | 3.55 | 3.56 | 4.55 | 6.92 | 5.97 | 4.63 |
| Other weather disasters | 2.38 | 1.18 | 1.78 | 4.55 | 3.77 | 4.1 | 2.81 |
| Potato damage caused by animal | 0 | 1.18 | 0.59 | 0.91 | 0.63 | 0.75 | 0.66 |
| Others | 0 | 0.59 | 0.3 | 0.91 | 1.26 | 1.12 | 0.66 |

Table 71. Potato production and sales of potato farming household

| | Anding | | | Dongxiang | | | Total |
|---|---|---|---|---|---|---|---|
| | Lujiagou | Gejiacha | Subtotal | Dashu | Beiling | subtotal | |
| Potato yield (ton/mu) | 0.45 | 0.59 | 0.53 | 0.69 | 0.60 | 0.65 | 0.59 |
| Selling price (yuan/kg) | 0.80 | 0.70 | 0.72 | 0.96 | 0.91 | 0.94 | 0.75 |
| Selling quantity (kg) | 600.31 | 1245.49 | 978.27 | 53.55 | 28.14 | 40.92 | 456.83 |

Table 72. Irrigation, mechanization and livestock usage in the largest two potato farmlands of potato farming household, by plot of land in Dongxiang

| | Dashu | | Beiling | | Total | |
|---|---|---|---|---|---|---|
| | 1st plot | 2nd plot | 1st plot | 2nd plot | 1st plot | 2nd plot |
| Irrigation | | | | | | |
| Share of farming households irrigate potato? (%) | 0.61 | 3.23 | 0 | 0 | 0.31 | 1.64 |
| Irrigation cost (yuan/mu) | .09 | .48 | 0 | 0 | 0.04 | 0.24 |
| Mechanization | | | | | | |
| Share of farming households use at less one agricultural machinery? (%) | 53.85 | 70.59 | 47.34 | 50 | 50.59 | 60.29 |
| Number of machinery worked (workday/mu) | .96 | .95 | 1.10 | 1 | 1.03 | .98 |
| Machinery type (% of potato farming households) | | | | | | |
| a) Transport machinery | 32.48 | 31.03 | 34.09 | 42.11 | 33.17 | 34.69 |
| b) Rotary cultivator | 15.38 | 31.03 | 12.50 | 5.26 | 14.15 | 8.16 |
| c) Tractor | 46.15 | 51.72 | 46.59 | 47.37 | 46.34 | 51.02 |
| d) Others | 5.98 | 6.9 | 6.81 | 5.26 | 6.34 | 6.12 |
| Source of Machinery (% of potato farming households) | | | | | | |
| Owned | 31.30 | 34.48 | 37.50 | 68.42 | 33.99 | 47.92 |
| Rented | 57.39 | 48.28 | 52.27 | 26.32 | 55.17 | 39.58 |
| Outsourced | 11.30 | 17.24 | 10.23 | 5.26 | 10.84 | 12.5 |
| Livestock | | | | | | |
| Share of farming households used livestock for potato planting? (%) | 62.13 | 52.94 | 69.28 | 81.82 | 65.67 | 66.18 |
| Number of livestock worked (workday/mu) | 3.09 | 1.89 | 3.71 | 3.32 | 3.42 | 2.75 |
| Source of Livestock (% of potato farming households) | | | | | | |
| Owned | 86.67 | 94.44 | 73.3 | 87.5 | 79.6 | 90.21 |
| Rented | 12.38 | 5.56 | 26.7 | 12.5 | 19.95 | 9.79 |
| Outsourced | 0.95 | 0 | 0 | 0 | 0.45 | 0 |

Table 73. Irrigation, mechanization and livestock usage in the largest two potato farmlands of potato farming household, by plot of land in Anding

| | Lujiagou | | Gejiacha | | Total | |
|---|---|---|---|---|---|---|
| | 1st plot | 2nd plot | 1st plot | 2nd plot | 1st plot | 2nd plot |
| Irrigation | | | | | | |
| Share of farming households irrigate potato? (%) | 1.88 | 0 | 0 | 0 | 0.78 | 0 |
| Irrigation cost (yuan/mu) | 2.06 | 0 | 0 | 0 | 0.85 | 0 |
| Mechanization | | | | | | |
| Share of farming households use at less one agricultural machinery? (%) | 87.39 | 81.25 | 72.96 | 75.90 | 78.89 | 77.39 |
| Number of Machinery worked (workday/mu) | 3.7 | .94 | 1.8 | 2.11 | 2.87 | 2.41 |
| Machinery type (% of potato farming households) | | | | | | |
| a) Transport machinery | 34.57 | 31.91 | 37.02 | 39.22 | 35.86 | 36.91 |
| b) Rotary cultivator | 38.89 | 39.36 | 30.39 | 26.47 | 34.40 | 30.54 |
| c) Tractor | 7.41 | 6.38 | 7.73 | 10.78 | 7.58 | 9.40 |
| d) Others | 19.13 | 22.34 | 24.86 | 23.52 | 22.15 | 23.15 |
| Source of machinery (% of potato farming households) | | | | | | |
| Owned | 62.73 | 75.51 | 79.56 | 86.27 | 71.64 | 82.78 |
| Rented | 32.92 | 22.45 | 12.71 | 7.84 | 22.22 | 12.58 |
| Outsourced | 4.35 | 2.04 | 7.73 | 5.88 | 6.14 | 4.64 |
| Livestock | | | | | | |
| Share of farming households used livestock for potato planting? (%) | 18.02 | 24.24 | 41.77 | 37.35 | 31.97 | 33.62 |
| Number of livestock worked (workday/mu) | 5.24 | 3.87 | 2.22 | 2.06 | 2.57 | 1.68 |
| Source of livestock (% of potato farming households) | | | | | | |
| Owned | 90 | 100 | 95.52 | 96.77 | 94.25 | 97.44 |
| Rented | 10 | 0 | 4.48 | 3.23 | 5.75 | 2.56 |
| Outsourced | 0 | 0 | 0 | 0 | 0 | 0 |

Table 74. Plastic mulch, fertilizer and chemicals utilization of potato farming household, by plot of land in Dongxiang

| | Dashu | | Beiling | | Total | |
|---|---|---|---|---|---|---|
| | 1st plot | 2nd plot | 1st plot | 2nd plot | 1st plot | 2nd plot |
| Plot area (mu) | 1.30 | 1.08 | 1.35 | .96 | 1.32 | 1.02 |
| Soil quality | | | | | | |
| Poor soil (% of potato farming households) | 14.97 | 14.71 | 19.53 | 8.82 | 17.26 | 11.76 |
| Common soil (% of potato farming households) | 49.70 | 50 | 44.38 | 70.59 | 47.02 | 60.29 |
| Good soil (% of potato farming households) | 35.33 | 35.29 | 36.09 | 20.59 | 35.71 | 27.94 |
| Plastic mulch | | | | | | |
| Share of farming households use plastic mulch? (%) | 10.65 | 14.71 | 3.55 | 2.86 | 7.10 | 8.70 |
| Share of farming households use black plastic mulch in those who use plastic? (%) | 0 | 0 | 16.67 | 100 | 4.17 | 16.67 |
| Share of farming households collect the mulch and take them home after harvesting (%) | 66.67 | 60 | 50 | 0 | 62.50 | 50 |
| Share of farming households collect the plastic mulch and give them to professional institution (%) | 11.11 | 0 | 16.67 | 0 | 12.50 | 0 |
| Farmyard manure | | | | | | |
| Share of farming households use farmyard manure? (%) | 62.72 | 76.47 | 72.78 | 70.59 | 67.75 | 73.53 |
| Farmyard manure (ton/mu) | .64 | .49 | .75 | .69 | .7 | .59 |
| Zinc fertilizer | | | | | | |
| Number of farming household applied zinc fertilizer | 0 | 0 | 1 | 0 | 1 | 0 |
| Other fertilizer | | | | | | |
| Share of farming households use other fertilizer besides zinc fertilizer? (%) | 98.82 | 100 | 96.45 | 100 | 97.63 | 100 |
| Amount of fertilizer applied (KG/mu) | 115.15 | 103.35 | 81.50 | 63.39 | 98.82 | 81.61 |
| Pesticides | | | | | | |
| Share of farming households use pesticides? (%) | 40.24 | 52.94 | 41.07 | 43.75 | 40.65 | 48.48 |
| Pesticides cost (yuan/mu) | 28.03 | 28.13 | 26.47 | 16.51 | 27.24 | 23.04 |
| Share of farming households use herbicide? (%) | 23.08 | 17.65 | 16.17 | 15.63 | 19.64 | 16.67 |
| Herbicide cost (yuan/mu) | 36.77 | 27 | 30.75 | 18.21 | 34.31 | 23 |

Table 75. Plastic mulch, fertilizer and chemicals utilization of potato farming household, by plot of land in Anding

| | Lujiagou | | Gejiacha | | Total | |
|---|---|---|---|---|---|---|
| | 1st plot | 2nd plot | 1st plot | 2nd plot | 1st plot | 2nd plot |
| Plot area (mu) | 2.56 | 2.14 | 2.52 | 1.79 | 2.53 | 1.88 |
| Soil quality | | | | | | |
| Poor soil (% of potato farming households) | 10.81 | 12.12 | 15.82 | 14.81 | 13.75 | 14.04 |
| Common soil (% of potato farming households) | 56.76 | 66.67 | 56.96 | 61.73 | 56.88 | 63.16 |
| Good soil (% of potato farming households) | 32.43 | 21.21 | 27.22 | 23.46 | 29.37 | 22.81 |
| Plastic mulch | | | | | | |
| Share of farming households use plastic mulch? (%) | 45.05 | 45.45 | 23.27 | 27.71 | 32.22 | 32.76 |
| Share of farming households use black plastic mulch in those who use plastic? (%) | 73.47 | 80 | 81.08 | 82.61 | 76.74 | 81.58 |
| Share of farming households collect the mulch and take them home after harvesting (%) | 44.68 | 40 | 58.33 | 68.18 | 50.60 | 56.76 |
| Share of farming households collect the plastic mulch and give them to professional institution (%) | 21.28 | 26.67 | 2.78 | 9.09 | 13.25 | 16.22 |
| Farmyard manure | | | | | | |
| Share of farming households use farmyard manure? (%) | 85.45 | 87.88 | 84.91 | 90.48 | 85.13 | 89.74 |
| Farmyard manure (ton/mu) | .59 | .47 | 1.01 | .79 | .84 | .71 |
| Zinc fertilizer | | | | | | |
| Number of farming household applied zinc fertilizer | 1 | 1 | 0 | 0 | 1 | 1 |
| Other fertilizer | | | | | | |
| Share of farming households use other fertilizer besides zinc fertilizer? (%) | 81.98 | 84.85 | 96.23 | 97.62 | 90.37 | 94.02 |
| Amount of fertilizer applied (KG/mu) | 48.77 | 36.55 | 53.78 | 48.79 | 52 | 45.70 |
| Pesticides | | | | | | |
| Share of farming households use pesticides? (%) | 11.71 | 9.09 | 19.11 | 25.61 | 16.04 | 20.87 |
| Pesticides cost (yuan/mu) | 14.83 | 12.8 | 18.03 | 23.70 | 17.07 | 22.34 |
| Share of farming households use herbicide? (%) | 25.45 | 27.27 | 27.85 | 34.57 | 26.87 | 32.46 |
| Herbicide cost (yuan/mu) | 18.46 | 19.67 | 25.60 | 16.26 | 22.94 | 16.96 |

Table 76. Top 3 fertilizer used in potato production by township in Dongxiang

| | Dashu | | | Beiling | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Top1 | Top2 | Top3 | Top1 | Top2 | Top3 | Top1 | Top2 | Top3 |
| Share of potato farming households use each fertilizer below | | | | | | | | | |
| Urea (%) | 65.27 | 29.20 | 12 | 73.01 | 15.46 | 12.50 | 69.3 | 23.61 | 12.2 |
| Diamines (%) | 4.79 | 4.38 | 44 | 5.52 | 23.71 | 18.75 | 5.17 | 12.45 | 34.15 |
| Phosphate (%) | 23.95 | 56.93 | 4 | 17.18 | 47.42 | 31.25 | 20.36 | 53.22 | 14.63 |
| Compound fertilizer (%) | 5.39 | 7.30 | 12 | 3.68 | 11.34 | 25 | 4.56 | 8.58 | 17.07 |
| Potato Special fertilizer (%) | 0 | 1.46 | 16 | 0.61 | 0 | 0 | 0.3 | 0.86 | 9.76 |
| Potash fertilizer (%) | 0 | 0.73 | 4 | 0 | 0 | 0 | 0 | 0.43 | 2.44 |
| Ammonium carbonate (%) | 0.60 | 0 | 8 | 0 | 2.06 | 12.50 | 0.3 | 0.86 | 9.76 |
| Nitrogen fertilizer (%) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Calcium carbonate (%) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Triamine (%) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Table 77. Top 3 fertilizer used in potato production by township in Anding

| | Lujiagou | | | Gejiacha | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Top1 | Top2 | Top3 | Top1 | Top2 | Top3 | Top1 | Top2 | Top3 |
| Share of potato farming households use each fertilizer below | | | | | | | | | |
| Urea (%) | 67.78 | 19.23 | 6.67 | 32.89 | 36.07 | 41.18 | 45.87 | 31.03 | 33.33 |
| Diamines (%) | 2.22 | 23.08 | 13.33 | 11.18 | 28.69 | 31.37 | 7.85 | 27.01 | 27.27 |
| Phosphate (%) | 10.00 | 25.00 | 13.33 | 32.24 | 18.85 | 3.92 | 23.97 | 20.69 | 6.06 |
| Compound fertilizer (%) | 6.67 | 5.77 | 26.67 | 5.26 | 3.28 | 1.96 | 5.79 | 4.02 | 7.58 |
| Potato special fertilizer (%) | 11.11 | 15.38 | 20 | 16.45 | 9.84 | 13.73 | 14.46 | 11.49 | 15.15 |
| Potash fertilizer (%) | 1.11 | 0 | 0 | 0 | 0 | 0 | 0.41 | 0 | 0 |
| Ammonium carbonate (%) | 0 | 11.54 | 20 | 1.97 | 3.28 | 3.92 | 1.24 | 5.75 | 7.58 |
| Nitrogen fertilizer (%) | 1.11 | 0 | 0 | 0 | 0 | 0 | 0.41 | 0 | 0 |
| Calcium carbonate (%) | 0 | 0 | 0 | 0 | 0 | 1.96 | 0 | 0 | 1.52 |
| Triamine (%) | 0 | 0 | 0 | 0 | 0 | 1.96 | 0 | 0 | 1.52 |

Table 78. Characteristics for potato selling by township in Anding

| | Lujiagou | Gejiacha | Total |
|---|---|---|---|
| | n=111 | n=159 | n=270 |
| Do you sell potato (% of total potato farming households) | 26.13 | 68.55 | 51.11 |
| Number of potatoes selling transaction | 1.17 | 1.34 | 1.31 |
| **Potato selling characteristics** | n=29 | n=109 | n=138 |
| Potato selling timing (% of total potato farming households who sold potato) | | | |
| Immediately after harvest | 79.31 | 81.48 | 81.02 |
| Several weeks later after being harvested | 10.34 | 3.7 | 5.11 |
| After storage | 10.34 | 14.81 | 13.87 |
| Potato buyers (% of total potato farming households who sold potato) | | | |
| Brokers | 6.9 | 7.34 | 7.25 |
| Local wholesalers | 34.48 | 61.47 | 55.8 |
| Potato processors | 37.93 | 8.26 | 14.49 |
| Others | 20.69 | 22.93 | 22.46 |
| Destination of the potato sold (% of total potato farming households who sold potato) | | | |
| Local (this village) | 20.69 | 43.12 | 38.41 |
| Other villages in this town | 31.03 | 51.38 | 47.1 |
| Other town in this county | 44.83 | 5.5 | 13.77 |
| Outside the county | 3.45 | 0 | 0.72 |
| Payment | | | |
| Share of farmers get cash payment (%) | 100 | 100 | 100 |
| Share of farmers who have deferred payment (%) | 3.45 | 5.5 | 5.07 |
| Deferred payment period (number of days) | 1 | 3.2 | 2.83 |
| Transportation | | | |
| Distance from farm gate to market (km) | 13.76 | 7.66 | 8.95 |
| Share of farmers responsible for transportation (%) | 51.72 | 58.72 | 57.25 |
| Transport cost (yuan) | 140 | 73.23 | 85.21 |
| Other cost besides transport (yuan) | 309.25 | 31.41 | 86.98 |
| Transaction time (hour) | 5.48 | 4.88 | 5.01 |

Table 79. Characteristics for potato selling by township in Dongxiang

| | Dashu | Beiling | Total |
|---|---|---|---|
| | n=169 | n=169 | n=338 |
| Do you sell potato (% of total potato farming households) | 7.1 | 4.14 | 5.62 |
| Number of potatoes selling transaction | 1 | 1 | 1 |
| **Potato selling characteristics** | n=12 | n=8 | n=20 |
| Potato selling timing (% of total potato farming households who sold potato) | | | |
| Immediately after harvest | 75 | 37.5 | 60 |
| Several weeks later after being harvested | 8.33 | 0 | 5 |
| After storage | 16.67 | 62.5 | 35 |
| Potato buyers (% of total potato farming households who sold potato) | | | |
| Brokers | 8.33 | 0 | 5 |
| Local wholesalers | 75 | 87.5 | 80 |
| Potato processors | 0 | 0 | 0 |
| Others | 16.67 | 12.5 | 15 |
| Destination of the potato sold (% of total potato farming households who sold potato) | | | |
| Local (this village) | 16.67 | 0 | 10 |
| Other villages in this town | 33.33 | 37.5 | 35 |
| Other town in this county | 50 | 62.5 | 55 |
| Outside the county | 0 | 0 | 0 |
| Payment | | | |
| Share of farmers get cash payment (%) | 100 | 100 | 100 |
| Share of farmers who have deferred payment (%) | 0 | 12.5 | 5 |
| Deferred payment period (number of days) | 0 | 1 | 1 |
| Transportation | | | |
| Distance from farm gate to market (km) | 18.91 | 13.65 | 16.81 |
| Share of farmers responsible for transportation (%) | 58.33 | 87.5 | 70 |
| Transport cost (yuan) | 70 | 60 | 65.33 |
| Other cost besides transport (yuan) | 13.41 | 8.87 | 11.6 |
| Transaction time (hour) | 3.5 | 2.75 | 3.2 |

Table 80. Potato production costs of potato farming household

| | Anding | | | Dongxiang | | | Total |
|---|---|---|---|---|---|---|---|
| | Lujiagou | Gejiacha | Subtotal | Dashu | Beiling | subtotal | |
| Total potato production cost (yuan/mu) | 240.34 | 216.56 | 226.34 | 396.77 | 495.41 | 452.32 | 351.97 |
| Labor (%) | 0.69 | 0.16 | 0.38 | 0.18 | 0 | 0.09 | 0.2 |
| Manure (%) | 2.89 | 0.59 | 1.53 | 0.07 | 0.34 | 0.21 | 0.8 |
| Plastic (%) | 15.03 | 9.38 | 11.7 | 2.2 | 0.81 | 1.5 | 6.03 |
| Irrigation (%) | 0.23 | 0 | 0.09 | 0.01 | 0.1 | 0.05 | 0.07 |
| Seed potato (%) | 8.9 | 8.66 | 8.76 | 20.14 | 43.14 | 31.67 | 21.49 |
| Fertilizer (%) | 42.14 | 55.74 | 50.16 | 60.39 | 46.11 | 53.23 | 51.86 |
| Pesticide/Herbicide (%) | 4.82 | 4.11 | 4.41 | 5.69 | 3.51 | 4.61 | 4.51 |
| Machinery (%) | 13.42 | 5.29 | 8.63 | 8.23 | 3.5 | 5.86 | 7.09 |
| Transport and others (%) | 11.82 | 16.02 | 14.3 | 3.05 | 2.44 | 2.75 | 7.88 |

Table 81. Number of sample preschoolers, students, and households in Anding by township

| | Lujiagou | | | | Gejiacha | | | |
|---|---|---|---|---|---|---|---|---|
| | Number of sample preshoolers and students | Number of sample households | Number of poor sample households | Number of sample households producing Potato | Number of sample preshoolers and students | Number of sample households | Number of poor sample households | Number of sample households producing Potato |
| Preschoolers | 89 | 80 | 27 | 34 | 103 | 89 | 21 | 65 |
| Grades 1-3 | 91 | 85 | 27 | 47 | 83 | 80 | 24 | 62 |
| Grades 4-6 | 75 | 70 | 27 | 43 | 80 | 77 | 30 | 60 |
| Total | 255 | 203 | 71 | 113 | 266 | 207 | 62 | 159 |

Table 82. Number of sample preschoolers, students, and households in Dongxiang by township

| | Dashu | | | | Beiling | | | |
|---|---|---|---|---|---|---|---|---|
| | Number of sample preshoolers and students | Number of sample households | Number of poor sample households | Number of sample households producing potato | Number of sample preshoolers and students | Number of sample households | Number of poor sample households | Number of sample households producing potato |
| Preschoolers | 90 | 76 | 40 | 70 | 89 | 83 | 55 | 71 |
| Grades 1-3 | 161 | 111 | 60 | 102 | 126 | 110 | 68 | 102 |
| Grades 4-6 | 112 | 87 | 47 | 81 | 79 | 70 | 43 | 68 |
| Total | 363 | 184 | 100 | 167 | 294 | 190 | 117 | 169 |